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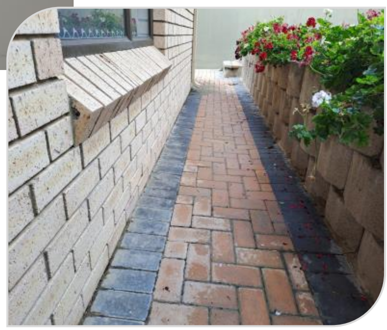

NATIONAL HOME BUILDERS NHBRC REGISTRATION COUNCIL

Professional Engineering Services

Investigation and Structural Engineering
Remedial Concepts to Erf 18471, Mossel Bay
House Bernard

Report – Rev 0

26 April 2024

Contact Person: **Melt Badenhorst** (Pr.Tech.Eng)

Document Control Sheet

Client Project Reference	**Internal Project Number**
Erf 18471, Mossel Bay (House Bernard)	TechQ – 023

Title

Professional Engineering Services: Forensic Investigation and Structural Engineering Remedial Concepts

Project Stage

Investigation and Concept Remedial Proposals

Version	Date	Comment
Rev 0	26 April 2024	Report submitted

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Reviewed By: (Client – NHBRC)

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A - Investigation (April 2024): Drawings

- Drawing No. House Bernard – Struct 01: Investigation and Structural remedial concepts

B - Architect drawings – May 2020 (Rudman & Visagie)

C - Geotechnical report - March 2024 (Dwala Group)

EXECUTIVE SUMMARY

This ***Forensic Investigation and Structural Engineering Remedial Concept Report*** is presented by **TechQ Development Pty (Ltd)** based on the *Request for Proposals (RFP)* called by the ***National Home Builders Registration Council (NHBRC)*** in terms of the *Housing Consumer Protection Measures Act (Act 95 of 1998) and Regulations (HCPMA), and the NHBRC Technical Requirements* **at *Erf 18471, Mossel Bay (House Bernard)***, Western Cape Province. This property forms part of the **"Seemeeu Heights"** development. A design review discussion session was held with the NHBRC on 22 April 2024, with relevant comments incorporated in this report.

The objective of the structural remedial concepts proposed within this report is towards a safe retaining structure and adequate stormwater management. Details on the investigation and structural engineering remedial concepts are provided on the drawings in **Annexure A.**

Documentation made available to **TechQ** included the municipal approved Architect's drawing and Geotechnical investigation, all noted in **Section 1.3**.

Section 2.2 of this report provides detail on the condition assessment of the structure and overall site properties, which portraits a sound building.

The concepts outlined in **Section 3** of this report are based on site inspections and the assessment done towards the complaints recorded by the Home Owner as record in the RFQ.

In summary, the following options are presented.

Section	Concept Remedial Actions
• **Foundations, walls and Stormwater**	**REMEDIAL A: Foundation Strengthening** • Concrete underpinning to foundations to large section of the house external footprint where settlement of foundations and structural cracks are evident.
	REMEDIAL B: Stormwater Management • Construct concrete aprons with open stormwater drainage channels. • Repair paving where necessary. • Install sub-soil drainage on eastern boundary of property
	REMEDIAL C: Crack Repair • Repair all mayor and small structural cracks emanating from settlement of foundations and lateral movement of walls.

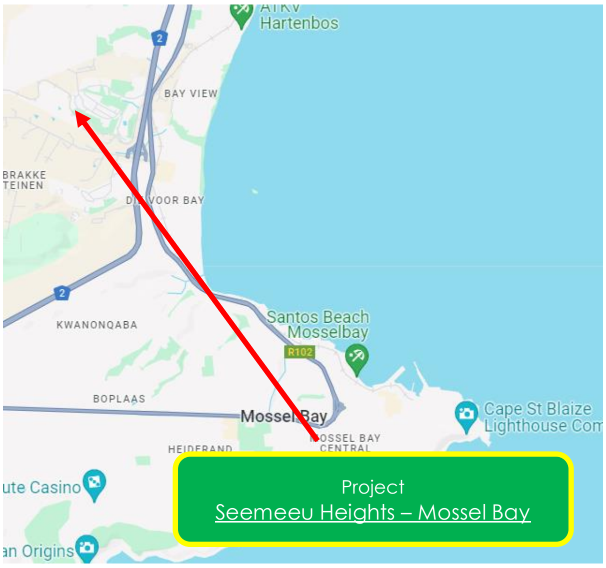
---- End of Executive Summary ---

1 PROJECT LOCALITY, SCOPE AND INFORMATION

1.1 Project Locality

Erf 18471, Mossel Bay (House Bernard) is located at *No.15, Seemeeu Heights, Mossel Bay* within the boundaries of the ***Mossel Bay Municipality*** as show on the Figures below.

Site coordinates are **South:** 34° 08' 17" **East:** 22° 05' 27"



Project Location: House Bernard – Seemeeu Heights

1.2 Scope of Work

TechQ Development (Pty) Ltd was appointed by the **NHBRC** to conduct a ***Structural Investigation*** towards the existing retaining wall at the back of the property with the following specific deliverables.

- Investigate defects that have manifested at the above-mentioned home and classify them in terms of the Housing Consumer Protection Measures Act (Act 95 of 1998) and Regulations (HCPMA) and the NHBRC Technical Requirements.
- Determine the root causes of defects, report on the deformation of the existing structure and provide remedial solutions and specifications including drawings where necessary, towards the following areas as per previous reports filed by the **NHBRC**:
  - Structural cracks on the external walls and internal walls

Throughout the investigation and considerations of remedial works, special attention is drawn to **Chapter III** of the Act, clause 13(1)(b) – (i) "rectify major structural defects" and (ii) "deviation from plans or any deficiency related to design, workmanship or materials".

1.3 Information Provided (Summary)

Information provided by the NHBRC, Home Owner and Engineering Service providers provided background to the site development and an understanding to analyse the structural system of the retaining wall in question and present concept structural proposals.

1.3.1 Architectural drawings – Annexure B

Municipal approved architect drawings dated May 2020 (**Rudman & Visagie Architecture**) provided information on the layout of the property and building elements.

The owner reported that they are the 2nd owner of the property and cracks have been developing fast the past few months, which were not present at the time of purchase.

1.3.2 Engineering drawings and Specifications

No structural engineering drawings providing details on the external or internal walls and associated stormwater or sub-soil drainage were made available during the investigation.

1.3.3 Geotechnical Investigation – Annexure C

The geotechnical investigations conducted on **erf 18471** by **Dwala Group** in March 2024 are summarised below.

- The site is underlain with residual siltstone with a high (45%) liquid limit and PI of 12%.
- Shallow seepage and groundwater is detected.
- Foundation materials comprises of soils with a 41% compressibility and 59% collapsible character.
- Site slope invites erosion and promotes surface runoff.
- Foundation strip footings constructed directly on compressible and high potential collapsible material.
- Foundations are not adequate and no proper engineering fill was used to prevent settlements of the foundations.
- Water ingress between paving bricks directly onto foundations.
- Poor installation of subsoil drains on eastern boundary.
- House is under structural destress with both horizontal and vertical cracks because of compression and differential settlement.

Two (2) test pits were prepared by **DWALA Group** at strategic positions around the building with images and short descriptions given below.

Test Pits:
Foundations constructed on silty material

Rainwater downpies
Water ingress into paving

Sub-soil drain on eastern boundary
Non-operational sub-soil drain

The Dwala Group report recommends underpinning to foundations and installation of proper stormwater management systems.

2 FORENSIC INVESTIGATION

2.1 Site Topographical Survey and Site Slope

No site survey information was made available during the forensic investigation, however, indicative contour levels were detected from the Architect's drawing indicating a 1,5m slope from south to north over the site extend.

This slope necessitates proper stormwater and sub-soil drainage to protect the foundations and adequately drain stormwater.

2.2 Condition Assessment of the building

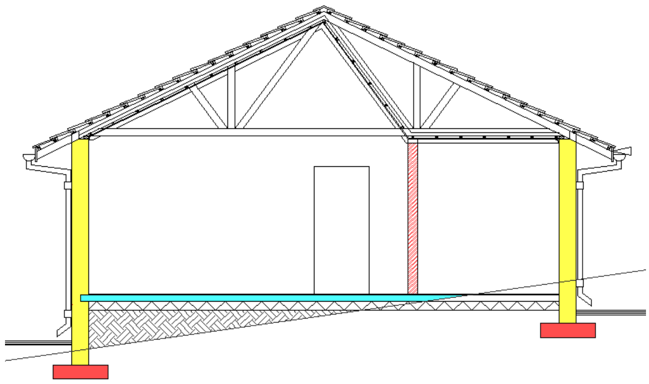
The table below and guided descriptions were used with the assessment and recommendations towards remedial works in securing a safe building

Table 1: Condition Assessment Ratings

Rating	Action required	Description
5 Very Good	Planned and Preventative Maintenance	New element or has recently been maintained, does not exhibit any signs of deterioration, and satisfies engineering specifications.
4 Good	Condition-based Maintenance	Superficial wear and tear, minor defects, minor signs of deterioration to elements and materials and requires routine maintenance / servicing.
3 Fair	Repairs needed	Require repair, usually by a specialist due to abnormal use or abuse and is in poor state of repair to affect surrounding elements.
2 Bad	Rehabilitation	Deterioration is bad, suffered structural damage and requires renovations. Serious potential of imminent failure which will lead to potential health and safety risk.
1 Very Bad	Structural rectifications/ Replacement	Element has failed its operational functions to the extent that does not justify repairs and needs to be replaced. The condition actively contributes to degradation of safety, health and risks.

The structural condition assessment of the building portraits a very high risk of failure towards the structural integrity of almost the entire building as schematically shown below.

Figure 2: Condition Assessment



Foundations	Very bad
Surface beds	Good
External brickworks	Bad
Internal brickwork	Very Bad
Timber roof	Bad
Stormwater provision	Very bad

The condition of the external walls are not as bad as the internal walls however, large cracks are evident over door and window openings on the perimeter of the building vertical walls.

2.3 Areas of Investigation

2.3.1 Stormwater

Segmented paving covers more than 80% of the property, however, water ingress is visible between the paving bricks due to settlement in the earth layer works. Numerous rainwater downpipes are also contributing to standing water on the surface in the absence of proper stormwater management.

As recorded in Section 1.3.3 above, a sub-soil drain was installed on the eastern boundary of the site, however not fully functional.

2.3.2 External walls, Internal walls, roof and surface beds

Settlement of pavement layers and ultimately the building foundation has resulted in medium to large cracks on both external and internal walls. Settlement of the building to the east has caused roof trussed to come loose from the brickworks.

Evidence of structural fatigue is noted at the kitchen window where a large crack divides all adjoining walls and pulls the wooden trusses from the external walls.

Possible underground heave soils are apparent from the large crack on the kitchen floor.

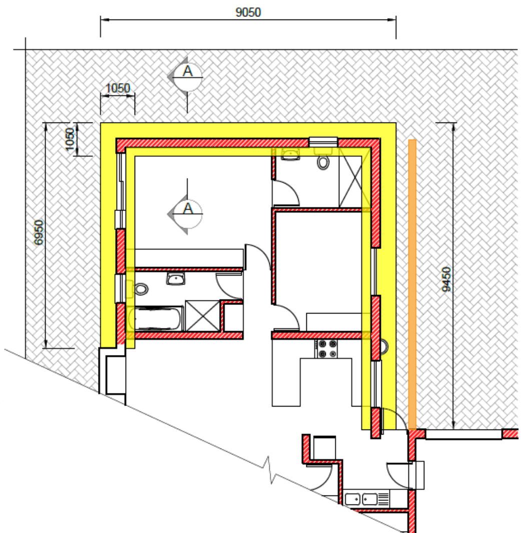
3 ENGINEERING REMEDIAL SOLUTIONS AND RECOMMENDATIONS

Contributing factors towards the **possible route causes** resulting in the large cracks forming on the external and internal walls are elaborated on in **Section 2.3** above.

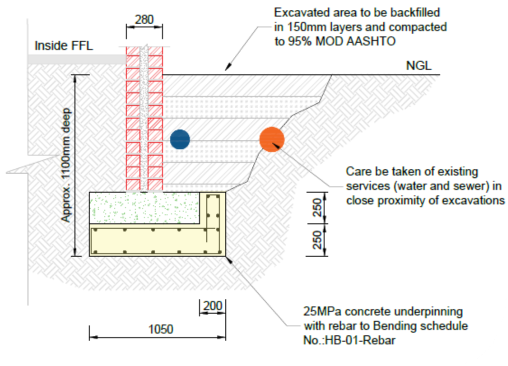
Engineering remedial concepts are categorised and described below with full details on the drawings attached as **Annexure A.**

3.1 Remedial A: Foundation strengthening

From the geotech report it is evident that no provision for engineering fill under foundations were done during construction. To stabilise the settlement, concrete underpinning is recommended to a large section of the external walls of the building as indicated on the drawings in **Annexure A** with graphical images below.



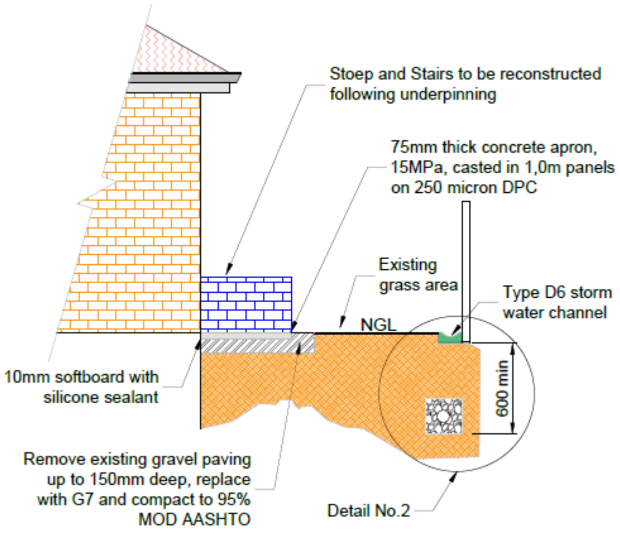
FOUNDATION STRENGTHENING
Concrete underpinning



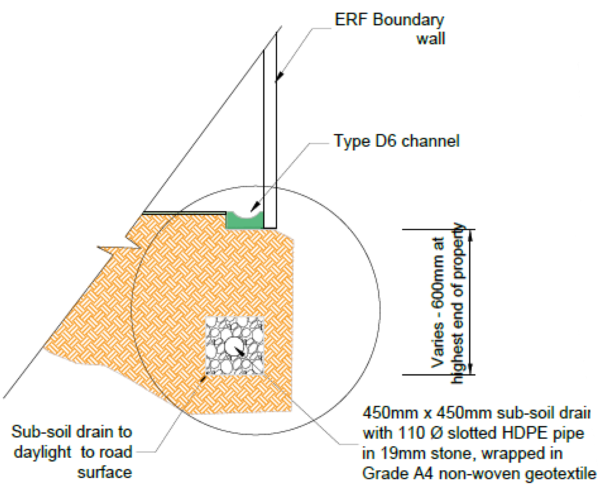
SECTION A - A
Concrete Underpinning

3.2 Remedial B: Stormwater Management

Apart from concrete aprons around the building perimeter, a proper sub-soil drain and open channel stormwater system is proposed to adequately drain run-off water away from the structure. Below is proposed concepts with detail on the attached drawing.



SECTION C - C
Apron, open channel and sub-soil drain

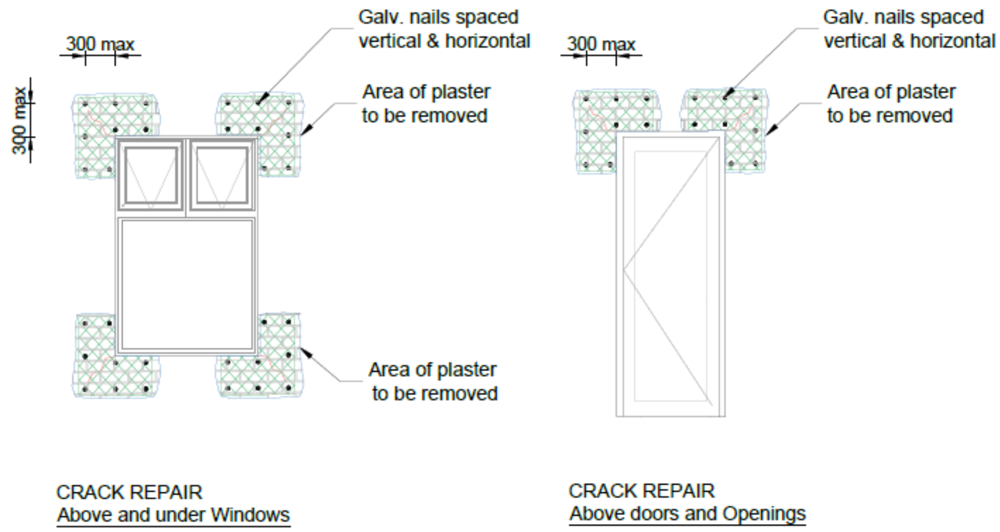


DETAIL No.2
Sub-soil drain

NOTE: Cognisance must be taken of the wooden garden hut at the southern elevation and two (2) sets of stoep / stairs on the eastern elevation of the building to be removed and replaced after the underpinning and aprons have been constructed.

3.3 Remedial C: Crack repair – Expanded metal lath

Expanded metal lath application repairs to low- and high-level cracks as detailed on the drawing as per the image below.



4 DESIGN PARAMETERS

The following section of the **Report** is towards Quality Assurance and Continuous Professional Development to ensure due diligence of **TechQ Development's** approach to engineering solutions and problem solving in following the statutory design standards, regulations and guidelines.

4.1 Design Standards, Regulations and Guidelines

The design of structural elements, additions to, maintenance and/or repair remedial measures of affected *structural engineering elements* for this Project, is in accordance with the guidelines as set out in the latest version of the following South African design standards (SANS) and the National Building Regulations (NBR).

- SANS 10400 – Parts H, J, K, L, M & P - Masonry building design
- SANS 10100 - Part 1 - Concrete Design
- SANS 10144 - Detailing of steel reinforcement for concrete
- SANS 0161 / SANS 10400 – Part H - Foundation Design
- SANS 10130-2 - Self-weight and imposed loads
- SANS 1200 - Standardised specifications for construction works

4.2 Design Working Life

All structural elements shall be so designed to have a 50-year lifespan: **SANS 10160-1, Table 1.**

Design working life category	Indicative design working life - years	Description of structures
3	50	Building structures and other common structures

4.3 Design Loads

4.3.1 Dead Loads (Permanent Actions)

SANS 10160-1 read in conjunction with the requirements of **SANS 10160-2** for self-weight and imposed loads is applicable to the following elements.

Load Imposed on	Cause of Load	Load Value
Slab	Screed & tiles	1,2 kN/m²
Slab	110mm Brick walls	19,0 kN/m³

4.3.2 Wind Loads (Variable Actions)

The following inputs are applicable in accordance with **SANS 10160-3** to calculate the peak wind speed pressure:

- Basic wind speed : 40 m/s
- Terrain Category : C (Regular cover of buildings, sub-urban terrain)
- Site Altitude : ± 25,0 MSL

4.3.3 Soil Loads

SANS 10160-1 read in conjunction with the requirements of **SANS 10160-5** will be applied.

4.3.4 Seismic Loads

The Project Site does not fall within either **Zone I or Zone II** and no specific seismic design requirements are needed.

4.4 Design Load Combinations

4.4.1 Ultimate Limit State

Ultimate limit state relates to the safety of the people and the structure. **SANS 10160-01** with reference according to **Table 3** outlines the Partial factors for actions for the ultimate limit state.

Dominating Action	Combination Name	Combination Equation
Self-weight	STR-P	1.35D + 1L
Imposed	STR	1.2D + 1.6L
Wind down	STR	1.2D + 1.3W↓ + 1.6ΨL
Wind up	STR	0.9D + 1.3W↑

4.5 Materials

4.5.1 Concrete and Reinforcement

The following key structural materials and specifications are proposed for the remedial Works.

a. <u>Concrete</u>

All reinforced concrete elements shall be designed in accordance with **SANS 0100-1**. The 28-day characteristic strength of all concrete elements is to be as per the table below.

Structural Elements	Concrete Grade	Stone size
Foundations, Column bases and stub-columns	30 MPa	19 mm
Surface beds	25 MPa	19 mm
Aprons and Ramps	25 MPa	13 mm

b. Reinforcement

- Mild steel or R-Bars f_y = 250 MPa minimum (to SANS 920)
- High yield or Y-Bars f_y = 450 MPa minimum (to SANS 920)
- Welded steel mesh f_y = 485 MPa minimum (to SANS 1024)

Bending schedules for the rebar to the concrete underpinning are detailed on the drawings and attached as **Annexure G.**

4.5.2 Masonry works

Where so detailed, specified and indicated on the drawings, typical **Type 2** (min) engineering bricks are to be used giving an **85mm** course height. All brickwork shall be set out in accordance with the relevant drawing layouts. Loadbearing brickwork should have a minimum crushing strength of **7MPa** with maximum 10% water absorption and **Class II** mortar.

4.6 Limiting Factors

Remedial and construction works as specified here within and detailed on the drawings, will require a ***strategic phased decanting program*** to be implemented during construction, drawn up in co-operation with the Home Owners. The safety of the Home Owners and the building need to be paramount, with construction works limiting the disruption of day-to-day and personal activities.

5 POSSIBLE ROUTE CAUSES OF DAMAGE AND CONCEPT PROPOSALS FOR REMEDIAL WORKS

Contributing factors towards the **possible route causes** resulting in the retaining wall to collapse can be some or a combination of the following.

- No engineering details towards proper measures in preventing settlement of underline soil materials or stabilisation of soils for foundations.
- Absence of proper stormwater features such as channels and sub-soil drainage.

The table below presents a summary to the forensic investigation and proposed concept options.

Section	Concept Remedial Actions
• **Foundations, walls and Stormwater**	**<u>REMEDIAL A: Foundation Strengthening</u>** • Concrete underpinning to foundations to large section of the house external footprint where settlement of foundations and structural cracks are evident.
	<u>REMEDIAL B: Stormwater Management</u> • Construct concrete aprons with open stormwater drainage channels. • Repair paving where necessary. • Install sub-soil drainage on eastern boundary of property
	<u>REMEDIAL C: Crack Repair</u> • Repair all mayor and small structural cracks emanating from settlement of foundations and lateral movement of walls.

6 RISKS & MITIGATION MEASURES

Qualifications, risks and possible sensitivity issues needs to be considered in performing the proposed remedial Works during the construction stage. The main objective of the Project is repair works to the structural deformation of the building, however, the following aspects with mitigation proposals, need to be taken into consideration in the Risk Register of the Project.

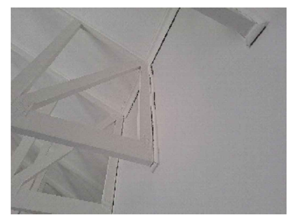
Risks and mitigation measures

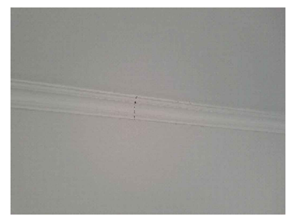
Nature of Risk	Risk	Mitigation
Site and Construction Risks	Abnormal rainfall and restricted working space	Proper scheduling of Works, being aware of the "critical path" items and implementing effective construction methodologies, Quality Assurance and Controls.
Limiting Factors	Decanting plan	Phased implementation of Works in accordance with proper planned decanting program.
Health and Safety	Delays and Fatal	Detailed OH&S plan compiled.
Quality Assurance	Construction Management	QA and QC Inspection procedures in place and approved
	Sub-standard materials	Quality tests and Agrements in place
OH&S and Environmental	Disturbance to environment, community and workers	Focus on the environment, building rubble disposals, air and noise pollution and disruption of day-to-day operations

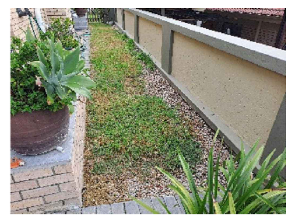
--- End of Report ---

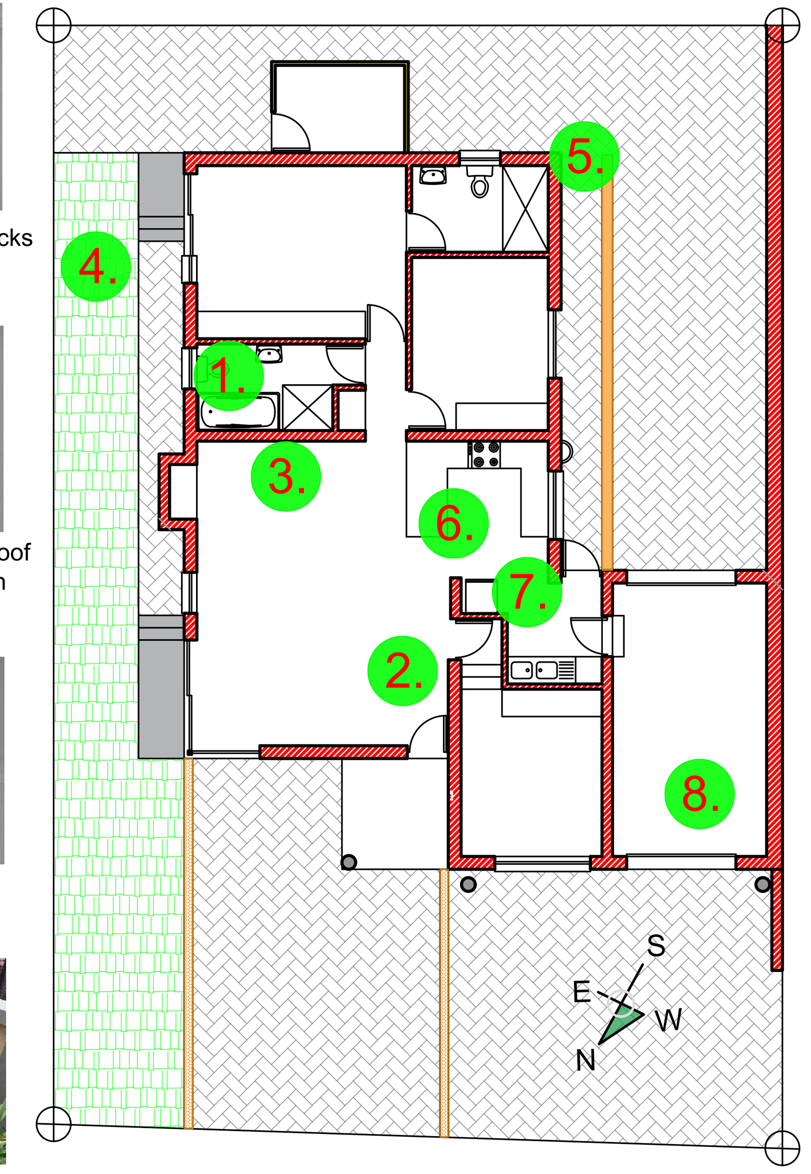
PROJECT SCOPE and INVESTIGATIVE NOTES

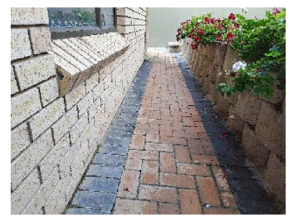

1. Vertical structural cracks in walls


2. Lateral movement of roof trusses due to foundation settlement


3. Roof cornicing coming loose from wall


4. Sagging of soils due to poor stormwater drainage



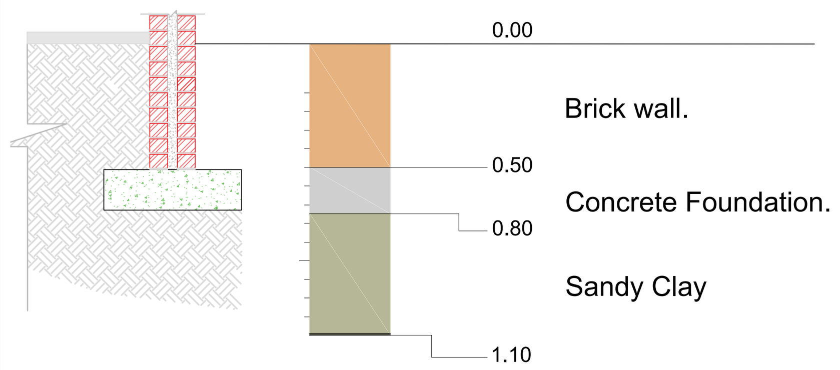

5. Water ingress in poorly drained paved areas


6. Crack in kitchen floor surface bed and tiles

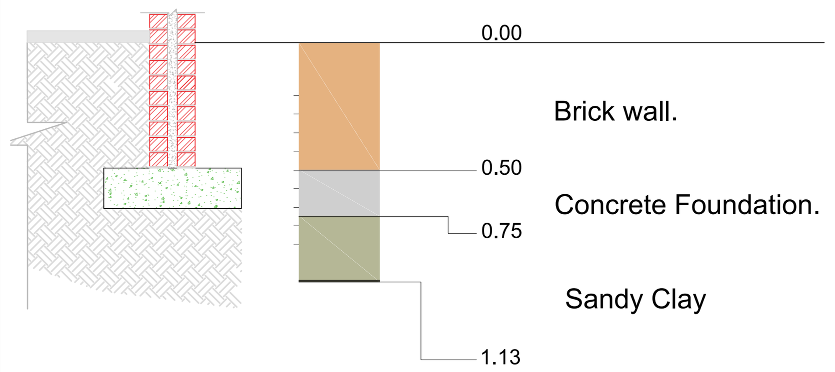

7. Diagonal structural crack in kitchen


8. Large crack in garage surface bed

GROUND FLOOR LAYOUT
Site / Building layout and Area of Investigation



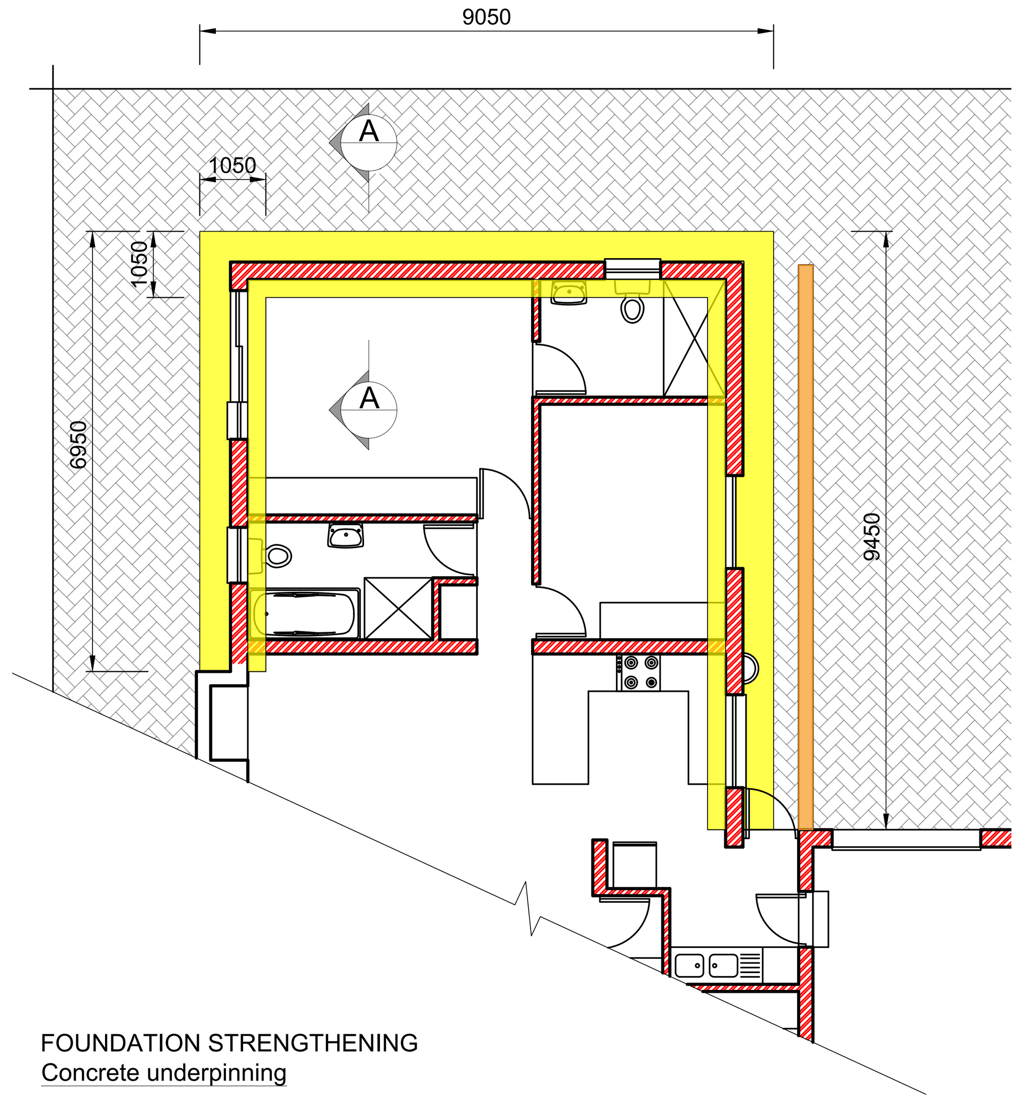
TEST PIT No. 1
South Elevation



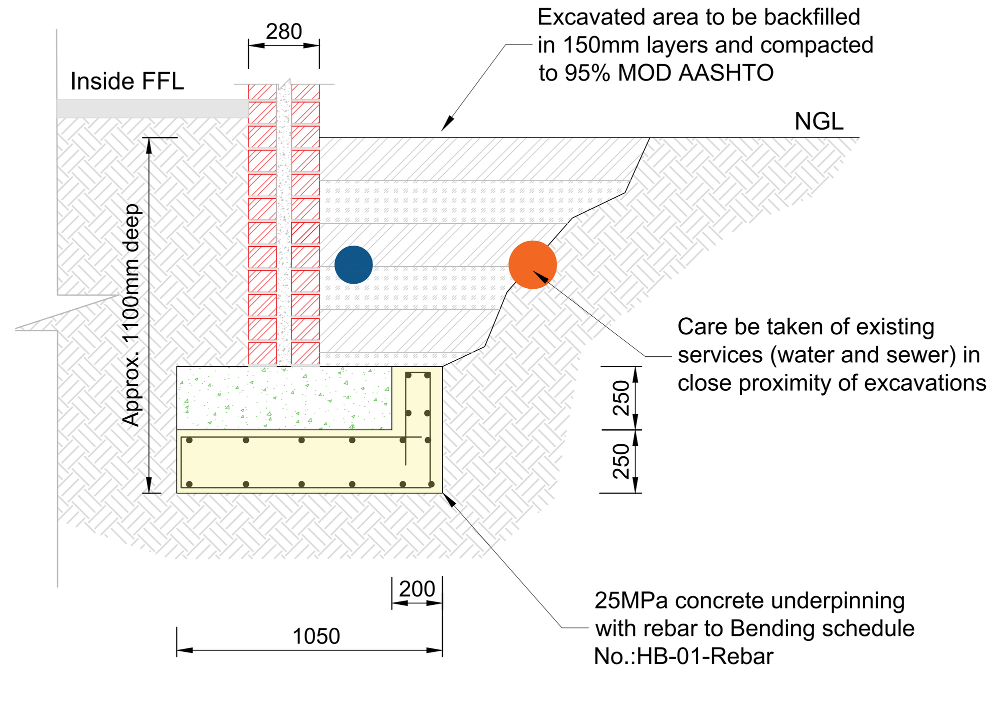
TEST PIT No. 2
East Elevation

POSSIBLE ROUTE CAUSES OF DEFECTS and REMEDIAL CONCEPTS

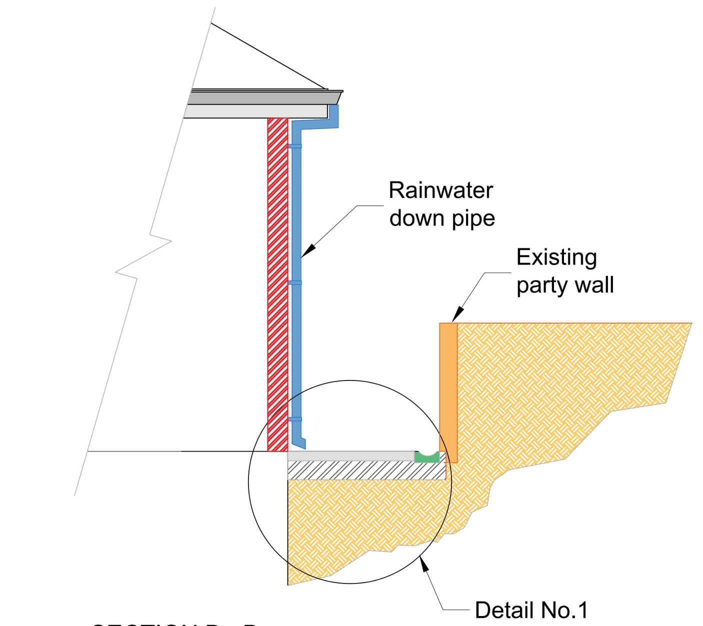
REMEDIAL A: FOUNDATION STRENGTHENING - Concrete underpinning



FOUNDATION STRENGTHENING
Concrete underpinning

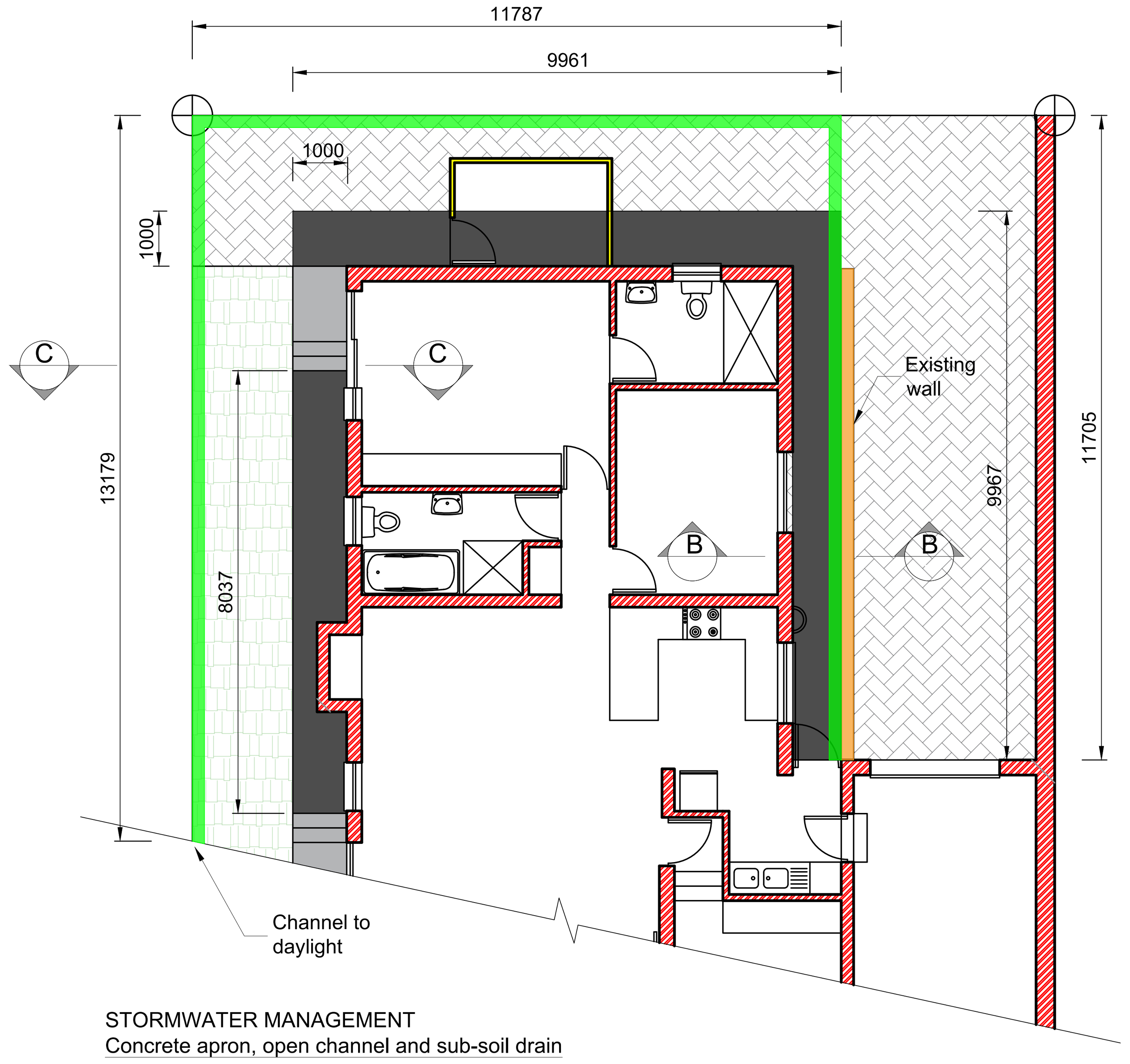


SECTION A - A
Concrete Underpinning

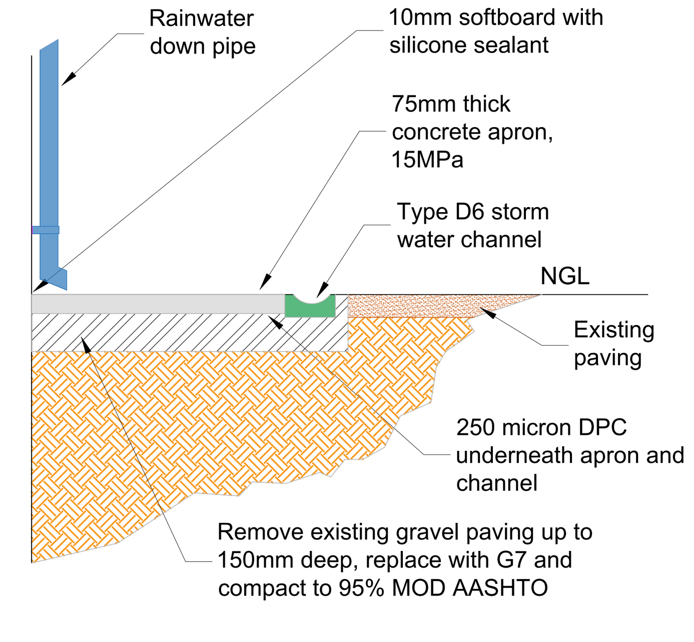


SECTION B - B
Apron and open channel

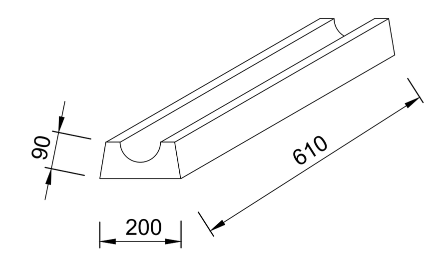
REMEDIAL B: STORMWATER MANAGEMENT - Apron and channel



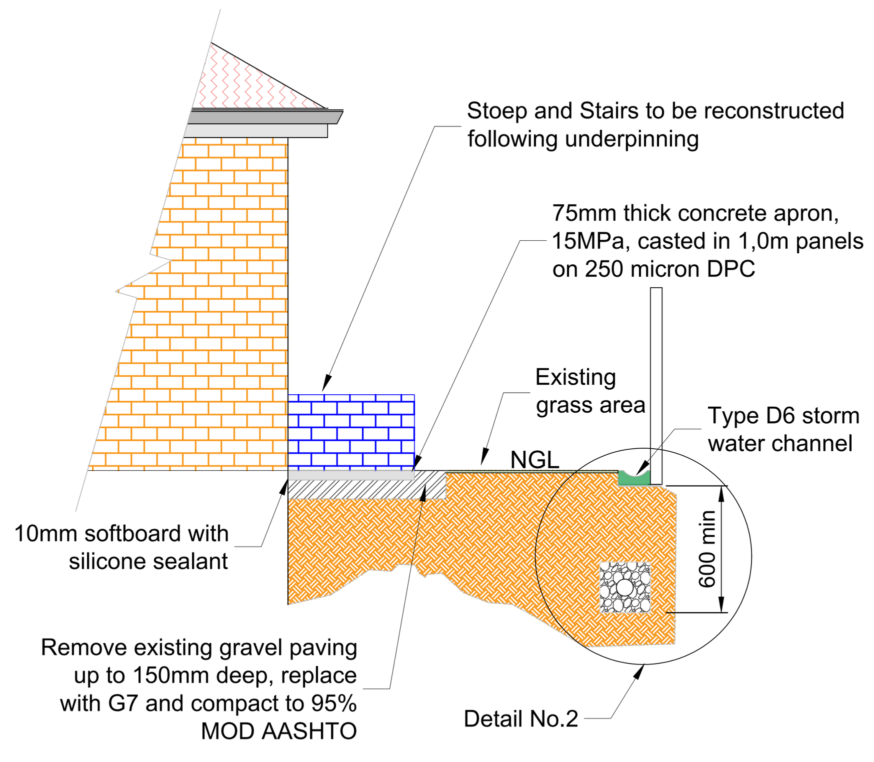
STORMWATER MANAGEMENT
Concrete apron, open channel and sub-soil drain



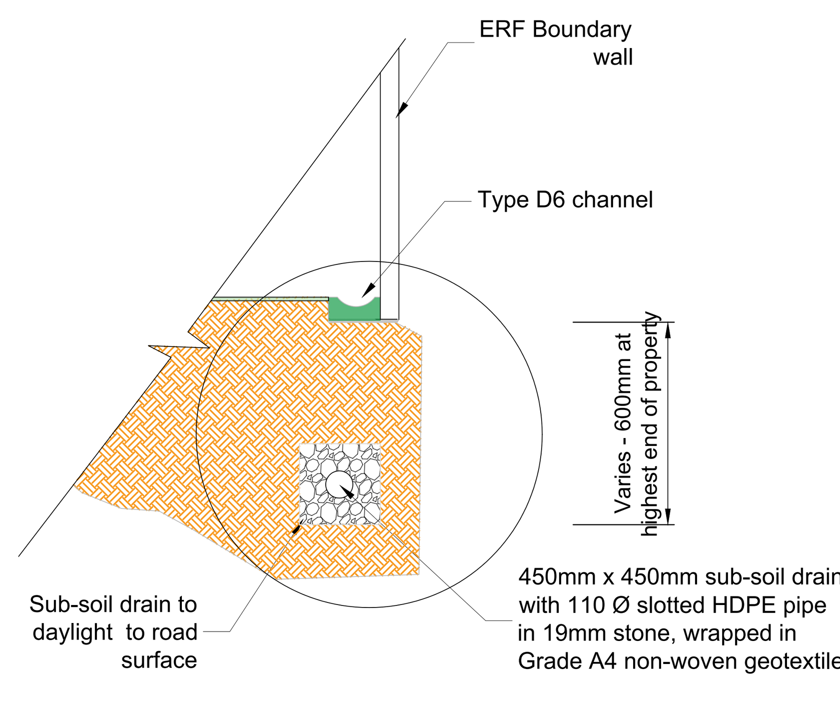
DETAIL No.1
Storm water drainage



PRECAST STORMWATER CHANNEL
Type - D6

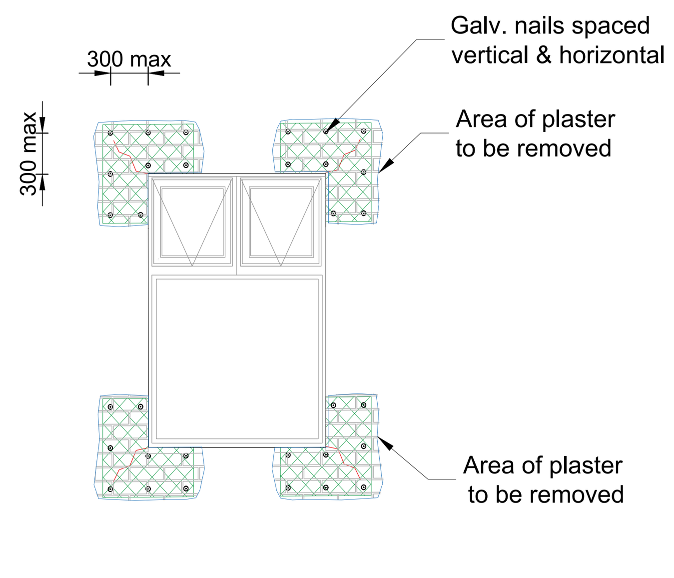


SECTION C - C
Apron, open channel and sub-soil drain

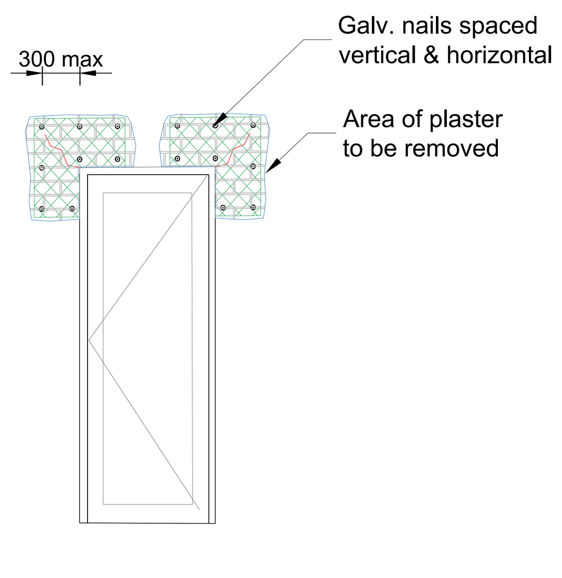


DETAIL No.2
Sub-soil drain

REMEDIAL C: CRACK REPAIR - Metal Lath



CRACK REPAIR
Above and under Windows



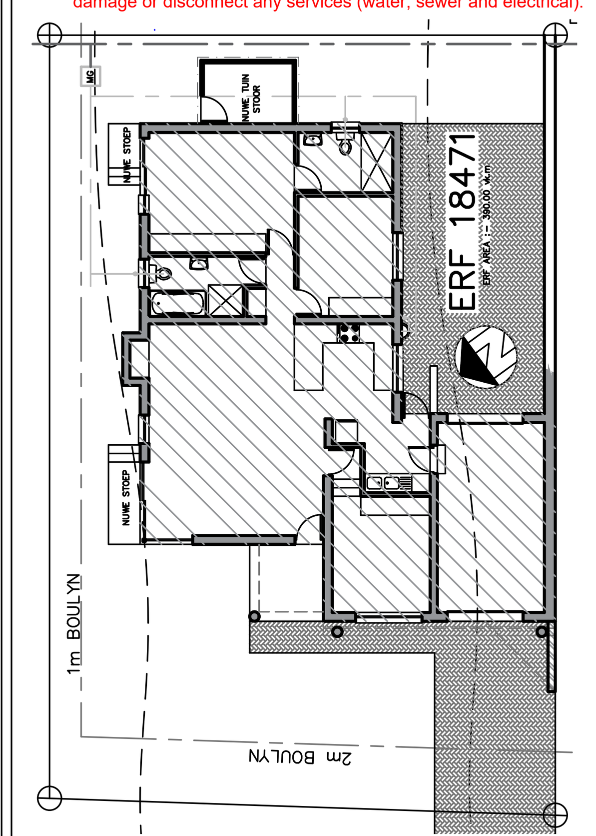
CRACK REPAIR
Above doors and Openings

CRACK REPAIR : EXPANDED METAL LATH
Procedures

1. Verify affected areas with the Engineer and remove plaster with light hand tools.
2. Light chisel opening - 5mm deep of apparent crack.
3. Fix galvinise lath mesh to area with galv. nails, 300mm max centers.
4. Lath metal tightly stretched to reduce waviness.
5. Plaster forced through openings of mesh so the lath is completely encased in the plaster (1:5 mix).
6. Repaint to mach existing.

NOTES:

1. This drawing to be read in conjunction with the following documents.
   * Forensic Report - 26 April 2024
2. No dimensions may be scaled from this drawing.
3. Special care to be taken during all construction operations to not damage or disconnect any services (water, sewer and electrical).



SITE LAYOUT:
ERF 18471, Mossel Bay - House Bernard

CLIENT
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REGISTRATION COUNCIL
Centennial Place
East Block
Century City Boulevard
Milnerton
Tel: (021) 913 9210
Cell: (083) 475 3546
e-mail: dalilsom@nhbrc.org.za

PROJECT TITLE
Structural Engineering Services for
Erf 18471, Mossel Bay
(House Bernard)

DRAWING TITLE
Structural Investigation, Possible causes
and Proposed Remedial Works

Revisions

Date	No.	Description

Reference Drawings

Dwg Number	Description

Drawing Issued for / as:
● Structural investigation
○ Design
○ Construction
○ As-built

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184 Lancaster Road
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Fax: (086) 474 1937
e-mail: techq.development@outlook.com

NEW DEVELOPMENT		MAINTENANCE	YES
DATE April 2024	DRAWN MJB	SCALE AS-SHOWN	CHECKED MJB
NHBRC SITE CLASSIFICATION:	NA	BEARING CAPACITY	NA

Stand Nr. and locality:
ERF 18471, Mossel Bay
Vyf Brakke Fonteinen

ENGINEERING DESIGNS – Structural & Civil services

Designed by:	Drawn:	Checked:
M.J. Badenhorst	MJB	MJB

Competent Person:
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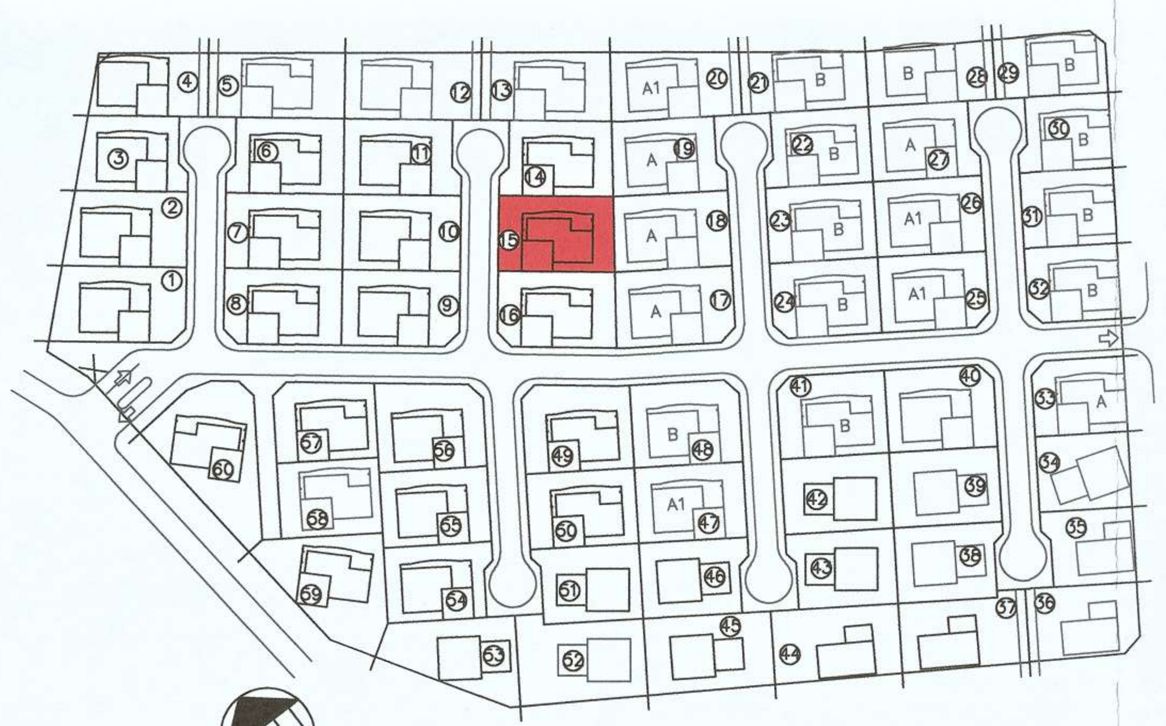
ECSA # 200270009
NHBRC Code # 601551
Cell: 066 105 1226
meltbadenhorst@outlook.com
Signature:

Drawing number:	Drawing size:	Rev.
House Bernard – Struct 01	A1	00

Client Approval:
Signature:



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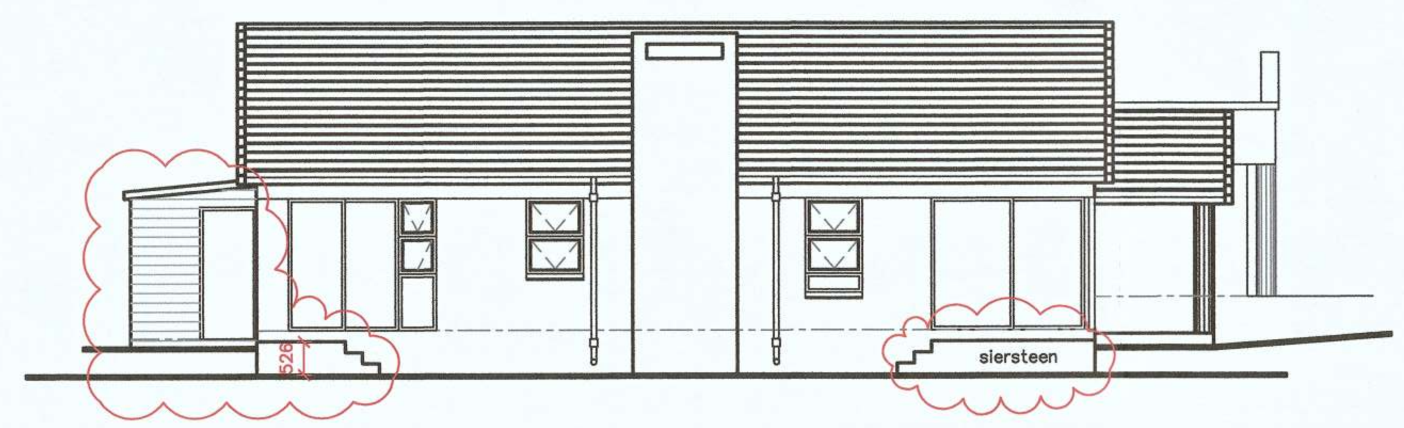

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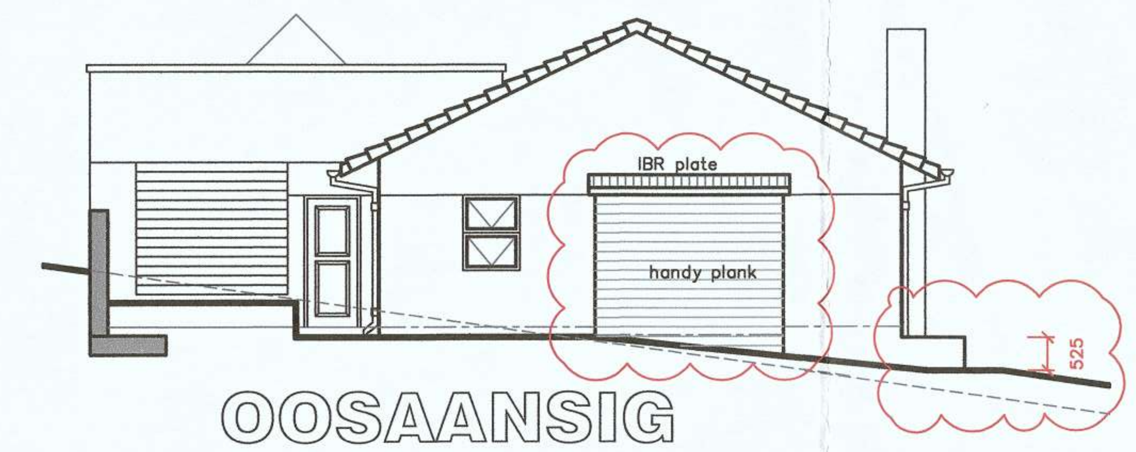

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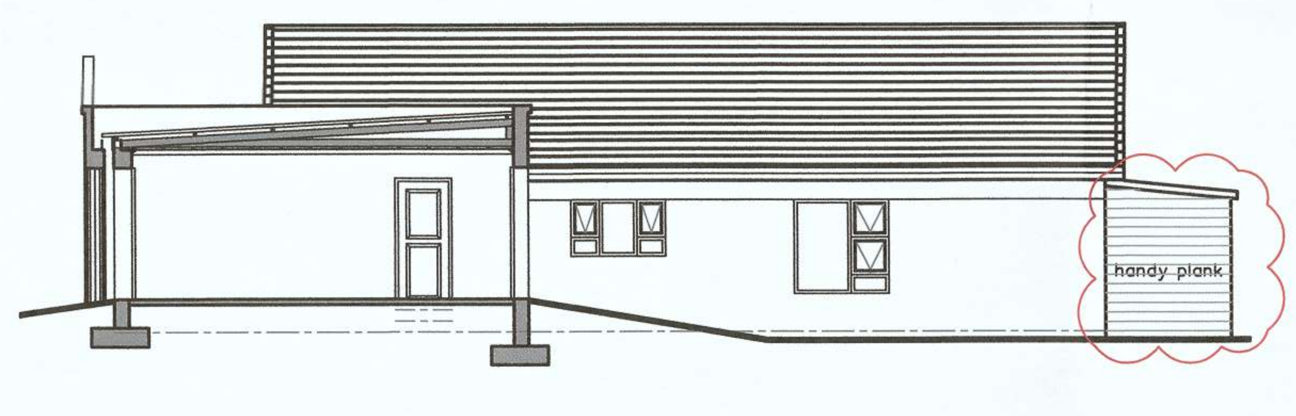

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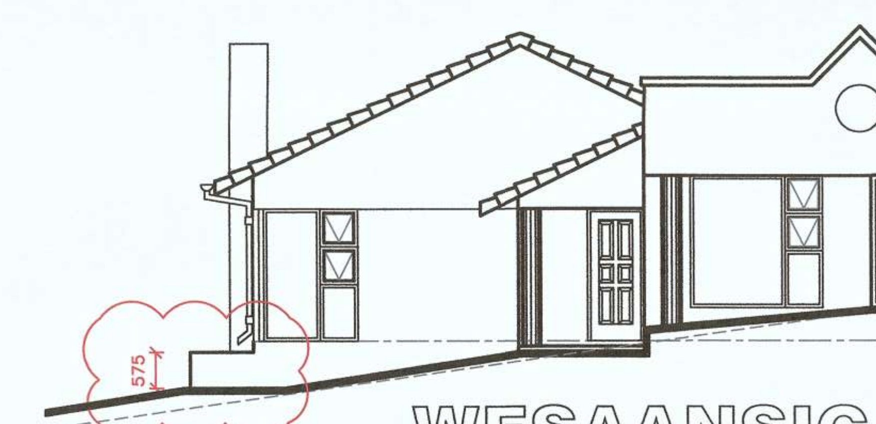

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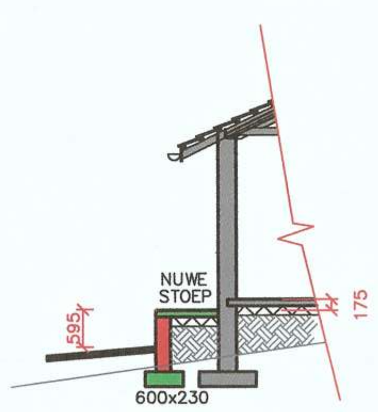
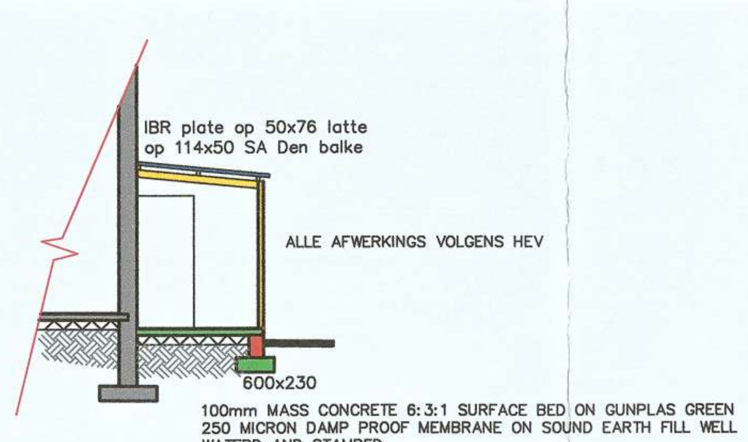


SNIT A-A 1:100



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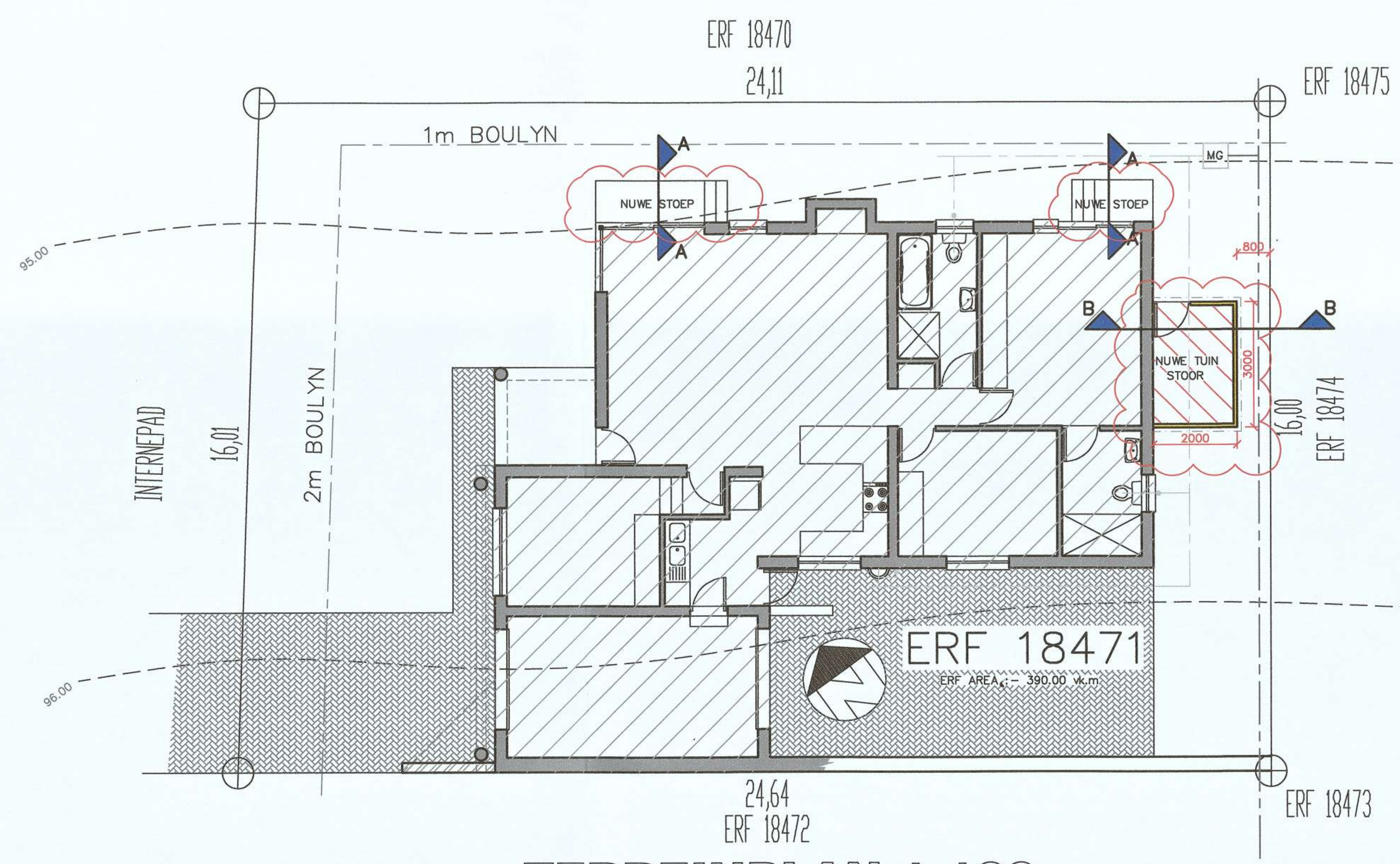

TERREINPLAN 1:100

Nuwe tuin stoor 6m²

GENERAL NOTES

1. ALL WORK TO COMPLY WITH LOCAL AUTHORITIES REQUIREMENTS, BYLAWS AND NATIONAL BUILDING REGULATIONS. (ACT No. 103 OF 1977.) AND ESCOM WIRING REGULATIONS.
2. ALL THE DIMENSIONS ON THE PLAN ARE TO BE CHECKED BEFORE PUTTING WORK IN HAND.
3. WRITTEN DIMENSIONS TO TAKE PREFERANCE TO SCALING FROM DRAWINGS.
4. ALL DETAILS TO BE READ IN CONJUNCTION WITH PLANS AND SECTIONS.
5. ALL GROUND LEVELS TO BE CHECKED ON SITE PRIOR TO ANY WORK. GROUND LEVELS ON PLAN ARE ONLY FOR INDICATION.
6. 2,5mm BRICKFORCE TO BE USED IN ALL WALLS EVERY FOURTH COURSE, AND EVERY COARSE FOR FOUR LAYERS ABOVE ALL WINDOWS AND DOOR, WHERE AFTER EVERY FOURTH COARSE AGAIN.
7. 375 MICRON "BRICKGRIP" DAMP-PROOF COURSE, MUST BE USED UNDER ALL WALLS.

DAK ISOLASIE BEREKENINGS
(Sien ook NOTAS B1)

R-VALUE OF "FIBER GLASS BLANKET" (1mx1m)
1 / 0.040 = 25 m².K/W
3.7 - 0.7875 = 2.9125
R-VALUE OF "LAMBDABOARD" (1mx1m)
80mm LAMBDABOARD
3.33
STAANDAK (plate)
3.7 - 0.4 - 0.75(RFL) = 2.55
2.55 / 25 = 0.102

BELIGTING Maks 5W/vk.m =140.40 x 5	= 702W
12 BINNE LIGTE @ 30W / LIG =	360W
4 BUITE LIGTE @ 30W / LIG =	120W
TOTAAL	= 480W

SEEMEEU HOOGTE
Die Ontwikkelaar nms
Huis Eienaars Vereniging
Seemeeu Park Hartenbos

Naudius SMH
Handtekening
9/03/2020
Datum

VOORGESTELDE AREAS:-	
VLOER AREA	:- 112.95 vk.m
MOTORHUIS	:- 23.45 vk.m
ONDERDAK STOEP	:- 4.00 vk.m
TOTAAL	:-140.40 vk.m
DEKKING = 36 %	

Nuwe tuin stoor 6m²

ELECTRICAL LEGEND

	DSTV	P/P	PREPAID METER
	ALARM SENCOR		
	UNDER FLOOR HEATING CONTROLE		
	UNDER FLOOR HEATING		
	DIMMER		
	CEILING LIGHT FITTING		
	OUTSIDE LIGHT FITTING		
	12 V DOWNLIGHTER		
	SPEAKERS		
	SHAVING POINT		
	SINGLE 15 AMP PLUG 300 F.F.L.		
	DOUBLE 15 AMP PLUG 300 F.F.L.		
	DOUBLE 15 AMP PLUG 1200 F.F.L.		
T	TELEPHONE POINT.		
F	FAX. POINT		
	SWITCHBOARD		
	200 Lt. GEYSER IN ROOF SPACE		
	DOOR BELL AND CHIME		
	T.V. POINT.		

SCANNED

MOSSEL BAY MUNICIPALITY / MOSSELBAAI MUNISIPALITEIT
PLAN NO 521/20
ALLE WERKE MOET VOLDOEN AAN WET 103 VAN 1977, SANS 10400 ALLE RELEVANTE WETGEWING EN RAADSBELEIDE EN RAADSGOEDKEURINGS VOORWAARDES MOET STRENG NAGEKOM WORD.
ALL WORK TO COMPLY WITH ACT 103 OF 1977, SANS 10400, AND ALL RELEVANT LEGISLATION, COUNCIL DECISION, AND COUNCIL CONDITIONS OF APPROVAL MUST BE COMPLIED WITH.

MOSSEL BAY MUNICIPALITY / MOSSELBAAI MUNISIPALITEIT
PLAN NO 521/20 RECOMMENDED FOR APPROVAL I.T.O SECTION 6 OF ACT 103 OF 1977 AANBEVEEL VIR GOEDKEURING I.T.V. ARTIKEL 6 VAN WET 103 VAN 1977
DATE 11 MAY 2020
PP BUILDING CONTROL OFFICER / BOUBEHEERBEAMPTE
APPROVED I.T.O SECTION 7 OF ACT 103 OF 1977 / GOEDGEKEUR I.T.V. ARTIKEL 7 VAN WET 103 1977
SUBJECT TO CONDITIONS STIPULATED ON PLAN AND LETTER OF APPROVAL ONDERHEWIG AAN VOORWAARDES SOOS PER PLAN EN GOEDKEURINGSBRIEF
THIS APPROVAL IS VALID FOR 12 MONTHS/ HIERDIE GOEDKEURING IS GELDIG VIR 12 MAANDE
DATE 11 MAY 2020
MUNICIPAL MANAGER / MUNISIPALE BESTUURDER

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info@rudmanvisagie.co.za

DRAWING TITLE :	WERKSTEKENING (soos gebou)
PROJECT TITLE :	WYSIGINGS AAN BEST. WONING
STAND No. :	1 8 4 7 1
TOWNSHIP :	SEEMEEU HOOGTE Nr 15
MUNICIPALITY :	MOSSELBAAI
FOR OWNER :	Mnr J.S. TAIT
OWNER'S SIGNATURE :	
SCALE :	1:100 & 1:200
CREATED BY :	MVis
CAD NAME & No. :	C:\Marais
DATE :	FEB 2020

SOUTH AFRICAN COUNCIL FOR THE ARCHITECTURAL PROFESSION Reg Nr: T0027 - MARAIS VISAGIE

PROJECT No. 04/97 | DRAWING No. 15

REVISION No.
A B C

GEOTECHNICAL INVESTIGATION FOR 15 SEEMEEU HOOGTE, MOSSEL BAY

HOUSE BERNARD

Prepared By:

DWALA GROUP
GEOTECHNICAL ENGINEERING

Prepared For:

NATIONAL HOME BUILDERS
NHBRC
REGISTRATION COUNCIL

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Document control			
Report title	Geotechnical report for the proposed remedial works for a deforming house (House Bernard).		
Client	National Home Builders Registration Council (NHBRC)		
Date	24 March 2024	**Keywords**	
Compiled by:	Lethabo Moatshe	Residual material	Strip footing
Checked by:	Sboniso Zondi	Cracks	Compressible soil
Approved by:	Nhlanhla Magigaba	Concrete apron	Drainage measures
Rev	00		

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EXECUTIVE SUMMARY

NHBRC appointed Dwala Group to carry out a geotechnical investigation for a deforming structure (House Bernard). The study area is situated at 15 Seemeeu Hoogte in Vyf Brakke Fonteinen, Mossel Bay, in the Western Cape Province. The geotechnical investigation comprised of desktop study, fieldwork (test pit excavation, soil profiling, and sampling of selected horizon for laboratory testing), laboratory testing and reporting.

The main objective of the investigation was to investigate the cause of the deformation in the existing structure, evaluate the founding conditions, and give recommendations for remedial actions.

The geological profile revealed that the site is underlain by fill and residual siltstone material.

According to the geotechnical characteristics of the soil material encountered under the foundations, the investigated site is zoned as Zone C2. This zone covers the entire site and is characterized by the compressible, and potentially collapsible residual siltstone horizon (silty sands, clayey sand material). The expected total settlement for this zone is greater than 10 mm and a differential movement that is 75%.

It was observed during the investigations that the strip footings are placed directly on the compressible, and potentially collapsible material, as such, no measures were put in place to prevent differential settlement of residual siltstone **materials on site.**

Based on the soil profile characteristics and the condition of the structure, it is evident that the structure should have been founded either on a foundation of substantial stiffness if it had to perform satisfactorily. This would have required a soil raft of non-active material placed on a concrete raft foundation with high stiffness. This solution would typically be combined with limited articulation and a substantial brick force specification.

Due to the fact that the foundation materials below the foundation are compressible and potentially collapsible, the underpinning of the foundation is considered suitable for strengthening the foundation.

Measures to attempt to stabilise future soil moisture change and hence curb further movement as effectively as possible must be implemented.

1. Introduction

NHBRC appointed Dwala Group to carry out a geotechnical investigation for a deforming structure (House Bernard). The study area is situated at 15 Seemeeu Hoogte, Vyf Brakke Fonteinen in Mossel Bay, Western Cape Province. Fieldwork carried out on the 21st of February 2024, included excavation of test pits, soil profiling, soil sampling, and exposing existing foundations of the structure to assess the possible factors that might be causing the house to deform (crack).

The objectives of the geotechnical investigation were to:

- Present a discussion on the prevailing condition of the structure.
- Determine the stratigraphy of the site and its geotechnical properties.
- To determine whether any problem soils are present at the site that could have had an effect on either founding or construction methods for the structure to deform (crack).
- To delineate the site into appropriate geotechnical zones according to any essential differences in founding conditions encountered.
- To evaluate the founding conditions at the site and to recommend building precautions necessary for different geotechnical zones.
- To obtain basic data concerning the use of the in-situ materials for guideline purposes.
- To present findings and recommend measures to restrict or reduce further structural distress in the structure.

The approach to the investigation was to assess the status quo in terms of the characteristics of the soil profile and the measures implemented (if any) to protect the structure against potential differential movements. This is followed by recommendations on appropriate rectification measures.

2. Available information

At the time of the investigation, the following information was available:

- The 1:250 000 scale geological map of the Oudtshoorn Sheet 3322 (Council for Geosciences, 1979).
- Aerial photographs, sourced from Google Earth®.

3. Site locality and description

The investigated site is situated at 15 Seemeeu Hoogte in Vyf Brakke Fonteinen, Mossel Bay, in the Western Cape Province. The site is located approximately 12 km northwest of Mossel Bay Central. The property can be accessed from R102, onto Boekenhout Avenue, onto Kameeldoring Avenue, onto Wassenaar Street, and Rylaan 5 into Seemeeu Hoogte. The area consists of residential developments. Figure 1 below shows the site locality of the investigated house.

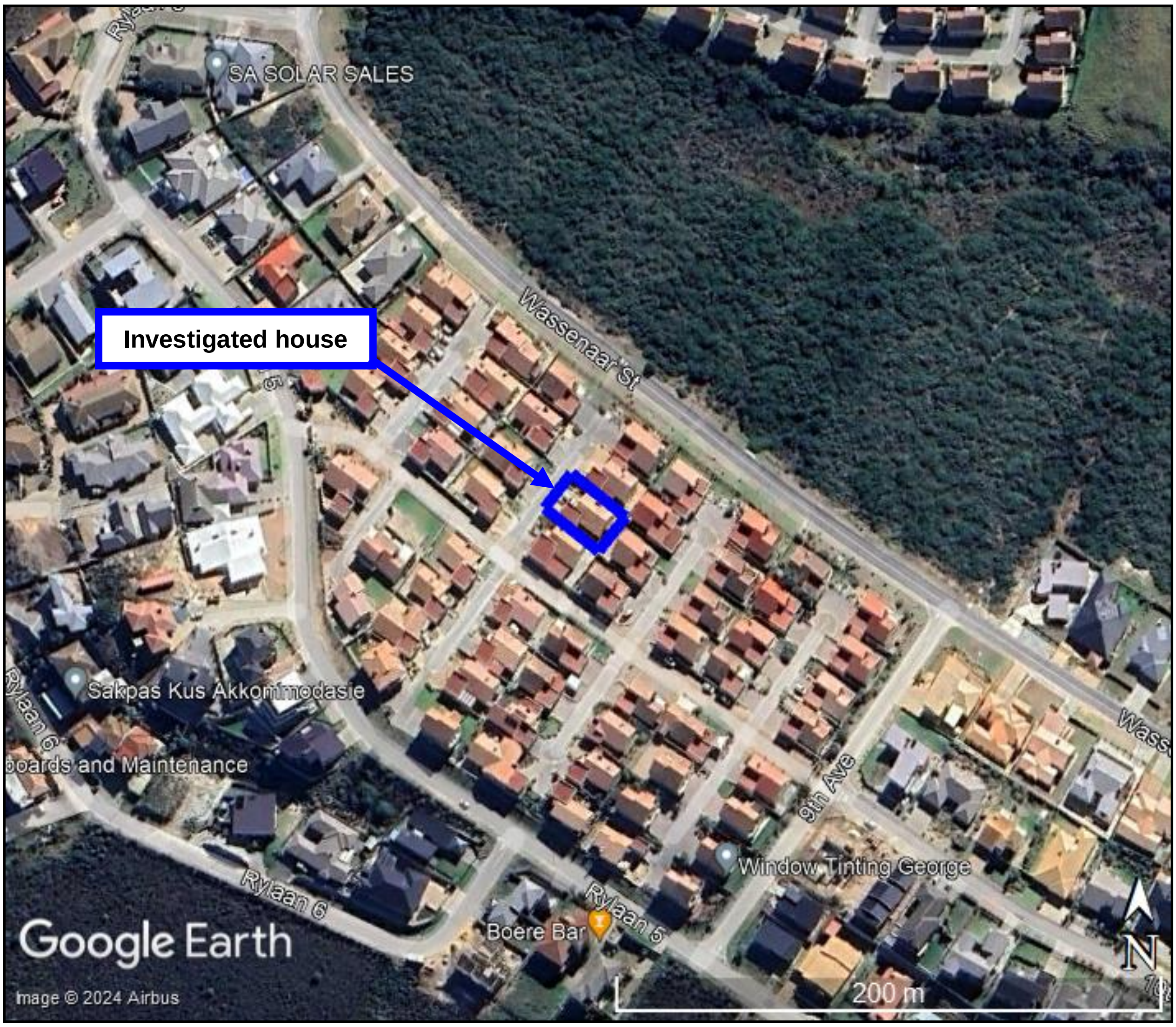

Figure 1: Showing the investigated house in Vyf Brakke Fonteinen, Mossel Bay (blue outline).

Topographically the property moderately slopes at an angle of approximately 6° towards the north-easterly direction.

The investigated house is covered by pavement all around the house as shown in Figure 2 below and grass and decorative stones on the northeast side of the house as shown in Figure 3 below.

Figure 2: Showing the topography of the site and the brick pavement around the house.

Figure 3: Showing the garden area on the property.

4. Climate

The climate in Mossel Bay is warm and temperate. The climate of the area is classified as Cfb by the Köppen-Geiger system. The temperature here averages 17.0°C. Mossel Bay has a lot of rainfall; even in the driest months, averaging 36 mm in February. In November, the precipitation reaches its peak, with an average of 56 mm. The rainfall is approximately 538 mm annually (Climate-data.org: 2012).

The Weinert Climatic N-number for the area (Weinert, 1980) is <5, which indicates that the climate is semi-humid to humid and chemical weathering processes are dominant.

5. Geology

According to a 1:250 000 scale geological map of the Oudtshoorn sheet 3322 (Council for Geoscience, 1979), the investigated site is underlain by conglomerate, sandstone, siltstone and clay of the Cretaceous to Tertiary Era. This lithology was confirmed in the test pits excavated on site. Figure 4 below shows the geological map of the investigated area.

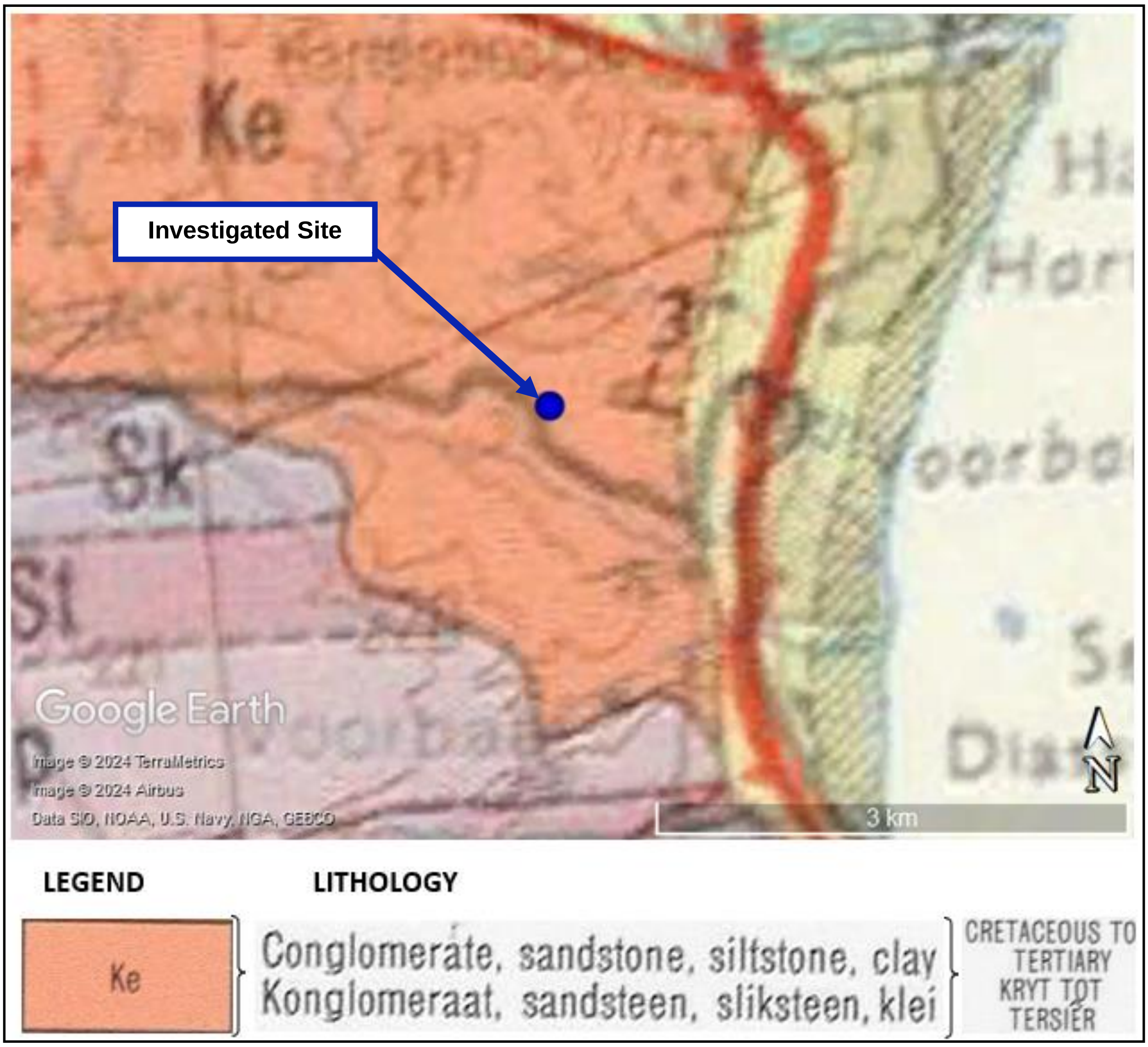

Figure 4: Showing the general geology map of the site; (Geological Survey, printed by the Government Printer, Pretoria, 1979).

6. Investigation Methodology

The geotechnical investigation comprised desktop study, fieldwork, laboratory testing and analysis and reporting.

6.1 Test pitting

To meet the requirements for a stand to be registered with NHBRC the investigation was carried out in accordance with the specification for geotechnical site investigations for housing developments (National Department of Housing specification GFSH- 2).

Fieldwork included excavation and profiling of two (2 No.) test pits excavated. One (1 No.) test pit was excavated next to the building to expose the foundations to have a clear understanding of the materials under the foundations. The other test pit was excavated to assess the stormwater drain on the northeast side of the house. To expose the foundation, the test pit was excavated to a depth of 1.50 m or to refusal on hard material.

A two-person team carried out the test pitting in order to comply with accepted safety requirements as reflected in the Site Investigation Code of Practice (SAICE, 2010). The test pits were set out and profiled by a team of engineering geologists/ geotechnical engineers in accordance with South African standards (*Jennings, J E B, Brink, A B A and Williams, A A B, (1973). Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. The Civil Engineer in S A, p 3-12. January 1973*.). Test pit details are summarised in Table 1 below.

Table 1: Test pit summary

Test Pit No	Coordinates (WGS84)		Depth (m)	Remarks
	Latitude	Longitude		
HB1	34° 8'17.09"S	22° 5'27.07"E	1.1 m	Refusal on dense residual siltstone
HB2	34° 8'16.88"S	22° 5'27.47"E	1.3 m	No Refusal

6.2 Laboratory testing

Representative samples were recovered and submitted to the SANAS-accredited Engineering Laboratory in George for testing. Soil testing included the determination of the Foundation Indicators (comprising sieve and hydrometer grading analyses and Atterberg Limits) as well as the determination of in-situ moisture content.

7. Results of Investigation

The detailed descriptions of the soil profiles encountered in the test pits are presented in Appendix B, while the soil profiles for the whole site are summarised below in Table 2.

Table 2: Test pit profile summary

Test Pit No	Brick Wall	Concrete Foundation	Fill horizon	Residual Siltstone horizon
HB1	0 – 0.50	0.50 – 0.80		0.80 – 1.10
HB2	-	-	00 – 1.30	-

Figure 5 below shows the excavated test pit HB1 on-site. The profile on-site consists of fill and residual siltstone horizon.

Figure 5: Showing test pit HB1.

7.1 Fill horizon

The fill horizon was encountered in one (1 No.) test pit HB2 excavated on site. The horizon comprises moist, dark brown, speckled grey, sandy clay with sparse gravel and pebbles. The overall consistency of this horizon is soft to firm.

Residual Siltstone Horizon

The residual siltstone horizon was encountered in one (1 No.) test pit HB1 excavated on site. The horizon comprises slightly moist to moist, olive green, dark reddish brown, mottled orangey, clayey sand with sparse gravel and pebbles. The overall consistency of this horizon is medium-dense.

8. Groundwater conditions

Groundwater seepage was not encountered in the test pits excavated on site.

9. Laboratory tests

Representative samples of the materials encountered on site were taken and submitted to a soil laboratory where they were subjected to the following tests:

- Grading and Atterberg Limits including moisture content.

The laboratory results are attached as Appendix C to this report.

9.1 Foundation Indicators

Representative samples were collected for laboratory testing and submitted for foundation indicator tests. The test results are attached in Appendix C and summarised in Table 3 below.

Table 3: Summary of Foundation Indicator test results

Hole no.	Depth (m)	Soil composition				GM	Atterberg limits			Activity	Moisture Content	Unified soil classification
		Clay (%)	Silt (%)	Sand (%)	Gravel (%)		LL (%)	PI (%)	LS (%)			
Residual Siltstone horizon												
HB1	0.75 – 1.40	24.0	17.0	44.0	15.0	1.03	45.0	12.0	6.0	Low	32.9	SM

Where:
GM = Grading modulus
LL = Liquid Limit
PI = Plasticity Index
LS = Linear Shrinkage
Activity = Expansiveness of the soil according to Van der Merwe's method
SM = Silty Sand

Table 3 above indicates that:

The **residual siltstone material** underlying the site consists of silty sand (**SM**) with a moisture content of 32.9%. The horizon has a high grading modulus of 1.03. The fine fractions of this material also exhibit moderate (45.0%) liquid limit as well as moderate (6.0%) linear shrinkage. The plasticity index (PI) of the material is moderate (12.0%). The material has a low potential expansiveness, according to the method proposed by Van der Merwe (1973).

10. Geotechnical Considerations

The following constraints, as proposed by Partridge, Wood, and Brink (1993), have to be considered for the classification of this site.

10.1 Shallow seepage/groundwater level

Groundwater seepage was not encountered in the test pits excavated on site.

However, at the time of the investigation, there was no effective moisture barrier around the house to protect the foundations and the soil under and around it from direct infiltration of water by draining them away to prevent foundation movement and structural damage. The underlying silty sand materials were encountered as very moist with a moisture content of 32.9% respectively, which indicates that water reaches the sub-foundation soils which is detrimental to the foundations and the structure of the house.

10.2 Compressible Soil Profile

The foundation indicator test results (see Section 9) indicate that the residual siltstone materials on-site comprise 41.0% fine-grained soils. Fine soils are prone to compressibility with changes in moisture content and additional load of the house.

The fine materials of the residual siltstone horizon where the foundations of the house are placed underwent compression and settlement when the moisture conditions under the foundations changed due to water permeating into the foundations and subsoil, seasonal rainfall, and the lack of a concrete apron around the house.

10.3 Collapsible soil profile

The foundation indicator test results (see Section 10) indicate that the residual siltstone horizon material on-site comprises 59.0% coarse-grained soils. Coarse-grained soils are prone to collapse upon wetting and additional loading.

The coarse materials of the residual siltstone material where the foundations of the investigated house are placed underwent collapse settlement when the moisture content increased in the subsoil under the foundations due to seasonal rainfall, and water draining directly into the soil and the foundations of the house as well as the additional load of the house.

10.4 Erodibility of the soil profile (present)

Due to the moderate slope of the area, erosion is occurring on the site as the slope promotes surface runoff. The residual siltstone materials at the site also consist of silt and fine sand materials which are prone to erodibility. Problems of erodibility exist on the site as water has infiltrated the foundations, and eroded the finer materials of the subsoil which has led to the collapse of the founding materials under the house. Surface runoff must be controlled on-site to protect the structures from further erosion of the surface and underlying founding materials.

It is recommended that surface drains be installed properly on the site to control surface water and drain water away from the foundations.

11. Current Site Conditions

11.1 Foundation conditions

Inspection of the foundations of the investigated house showed that the house is founded on “strip footings” with a thickness of 300 mm and a width of 960 mm. **The strip footings are placed directly on the compressible, and potentially collapsible material.**

The soil profile at the excavated test pit indicates that no proper measures (e.g. treatment/ improvement of the compressible, and potentially collapsible soil profile and/or replacement of compressible material with a properly engineered fill) were put in place to prevent settlement.

Furthermore, the residual siltstone horizon on site was encountered as moist with a moisture content of 32.9%. These materials undergo compression when moisture conditions change from dry to moist. This is problematic since inter alia seasonal moisture changes from dry to very moist in the foundation and sub-foundation horizons of especially lightly loaded fixed structures give rise to volumetric changes. Volumetric change in the soil skeleton in turn induces stresses in the footings and super-structure, leading to super-structure strain and cracking.

The foundations on site are considered to be inadequate to withstand the differential settlement that inevitably occurred due to the underlying compressible, and potentially collapsible materials; however, the structural engineer will confirm the suitability of the foundations.

11.2 Drainage Measures

A proper drainage system prevents water from accumulating around a house, potentially causing damage to its structure and/or foundations.

The gutters around the house channel water **directly onto the inadequate paving and into the foundations and subsoil.** This allows for water to permeate the soil directly and infiltrate through to the foundations facilitating the movement of foundations and leading to structural damage. Figure 6 below shows the gutters around the house.

Figure 6: Showing the gutters around the investigated house.

Upon exposure of the stormwater drainage pipe in the garden area, there were no visible signs of damage or leakage or disconnect. The pipe was encountered to be at a depth of 300 mm and extend to 1.0 m below the ground. Sandy clay with minor gravel and pebbles was used as backfill for the pipe. While the stormwater drainage system appears without visible damage, it should be noted that it cannot be definitively affirmed that there are no leakages during periods of heavy rainfall. Figure 7 below shows the stormwater pipe in the garden area.

Figure 7: Showing the stormwater pipe in the garden area.

11.3 Concrete Apron

The function of a concrete apron around a building is to protect the foundations and the soil under and around it from water and prevent it from directly infiltrating into the foundations by draining them away to prevent foundation movement and structural damage.

The brick pavement around the house is inadequate as there are spaces between the building walls and the brick pavement. This renders the pavement ineffective in keeping surface runoff away from the subsoils and subsequently the foundations. It allowed water to permeate through the foundations and the residual siltstone material directly, increasing the moisture content in the sub-foundation horizon. There are also signs of stagnant water on the pavers which is not drained away. Figure 8 below shows the inadequate brick paving around the investigated house.

Figure 8: Showing the inadequate brick pavement with spaces between bricks around the house.

The inadequate brick paving around the investigated house allowed water to permeate through to the foundations and directly into the foundations and subsoil residual siltstone **material. These materials absorbed the water and induced plastic deformations of the soils. The change in moisture content of the subsoil and the load of the house has triggered the compression/collapse and consequently differential settlement of the subsoil and thus caused the movement of foundations resulting in structural damage to the house.**

11.4 Structural conditions

The house under assessment displayed structural distress (lateral and vertical movement) because of compression and ultimately differential settlement. Cracks were observed on the interior walls of the house extending from the ceiling, corners of the windows and doors, and on the floors and tiles inside the house as shown in Figure 9 below and on the exterior walls as shown below in Figure 10. It is worth noting that this site most likely experiencing compression that heave.

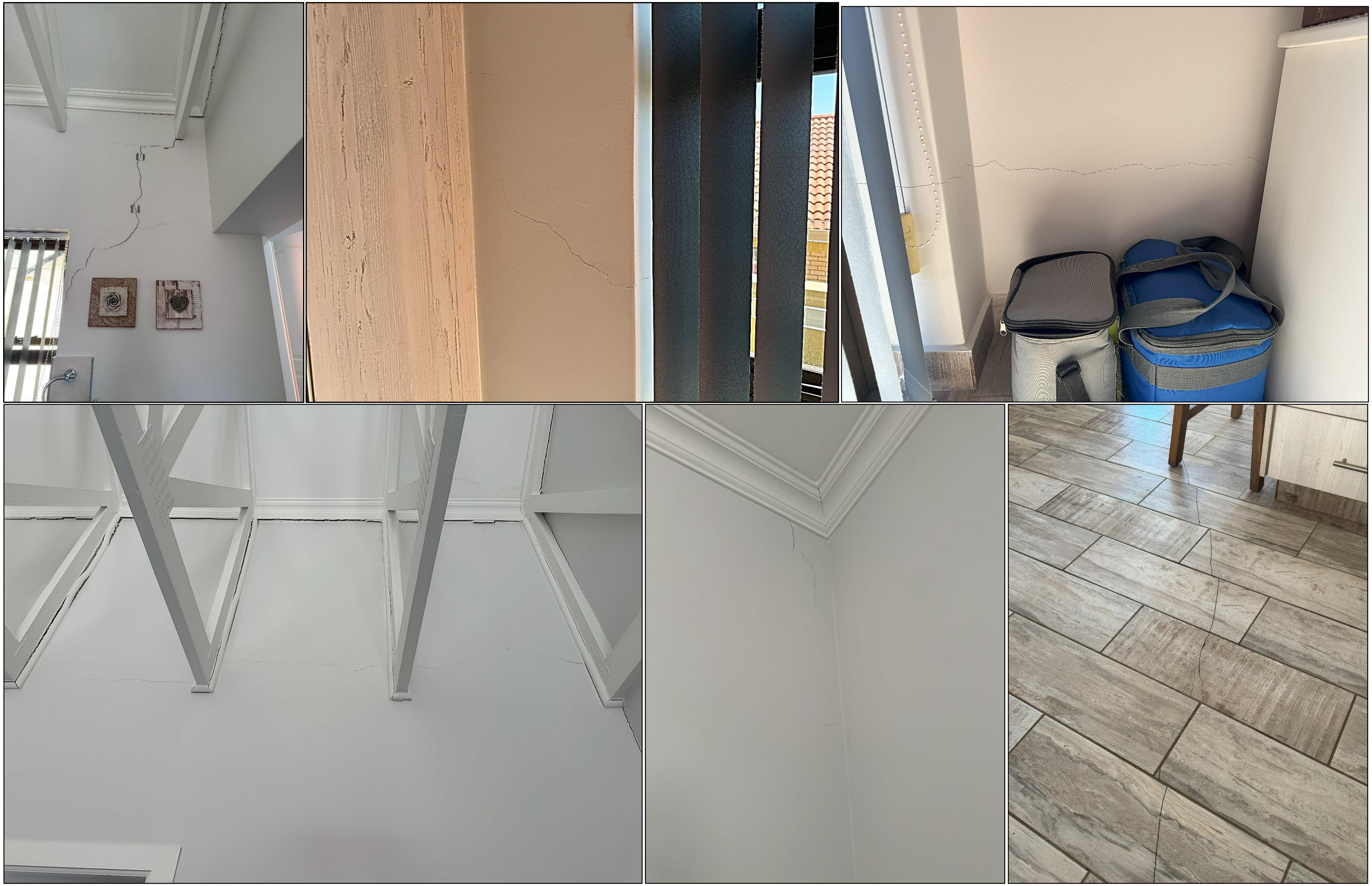

Figure 9: Showing the horizontal, diagonal, and vertical cracks on the interior walls of the investigated house.

Figure 10: Showing the cracks on the exterior walls around the investigated house.

The garden area and paving on the northeast side of the house has settled and a depression of the pavement is seen as shown in Figure 11 below.

Figure 11: Showing the settlement in pavement and garden area.

Based on the soil profile characteristics on the site and the condition of the structures, it is evident that the structures should have been founded either on a foundation of substantial stiffness if it had to perform satisfactorily. This would have required a soil raft of non-active material of about 1.50 m in thickness or a concrete raft foundation with high stiffness. These solutions would typically be combined with limited articulation and a substantial brick force specification.

12. Engineering Geological Zoning

For urban planning purposes, the site is zoned according to the NHBRC classification systems. Due to the presence of compressible, and potentially collapsible soil horizon under the entire site, the site has been delineated into one geotechnical zone. The descriptions of this zone are as follows:

Zone C2: This zone covers the entire site and is characterized by the compressible, and potentially collapsible residual siltstone horizon (silty sands, clayey sand material). The expected total settlement for this zone is greater than 10 mm and a differential movement that is 75% (**C2**).

Table 4: Geotechnical Characteristics

Geotechnical Characteristics				
Typical Founding Material	**Character of Founding Material**	**Expected Range of Total Soil Movements (Mm)**	**Assumed Differential Movement (% of Total)**	**Site Class**
Silty sands, sands, sandy and gravelly soils	Compressible and Potentially Collapsible Soils	<5,0 5,0-10,0 **>10,0**	75% 75% **75%**	C C1 **C2**

The expected immediate total settlement of the foundations in test pit HB1 is 17.00 mm on the residual siltstone material based on a founding depth of 0.80 m, a strip footing width of 0.96 mm and an in-situ stiffness of 7 MPa (using the method proposed by Janbu et.al, 1956).

Settlement larger than 10 mm is likely to be differential and may compromise the structure of the development. It is therefore recommended that the clay be treated and strip footings be placed on engineered fill. When the in-situ clay is treated and engineered fill placed on top, the settlements can be expected to drop below 10 mm.

The allowable bearing capacity (FoS=3) of this material is approximately 89kPa.

13. Conclusions

The conclusion of the investigation can be summarised as follows:

- The diagonal, vertical and horizontal cracks around the building indicate movement of the foundations.
- The residual siltstone material comprises predominantly silty sand material.
- The laboratory tests indicate that the soil profile has low potential expansiveness, however, it is compressible, and potentially collapsible due to the silty and sandy nature of the materials.
- Settlement calculations show that upon the change in moisture content of the sub-foundation soils on site, the average settlement for the site is approximately **17.0 mm**.
- **The structural distress which is observed on this site can mainly be ascribed to the expected differential settlement of 13.0 mm, which is a result of compressible, and collapsible material below the founding level.**
- **The house has no effective moisture barrier/apron. Concentration and discharging of rainwater, directly onto the soil and via downpipes, against the structure have increased the risk of differential settlement.**
- A depression and settlement of the pavement are noted along the northeastern side of the house near the stormwater pipe.
- The stormwater drainage pipe shows no signs of damage, it cannot be definitively affirmed that there are no leakages during periods of heavy rainfall.
- Cracks smaller than 0.5 mm could have been caused by a combination of settlement and temperature differences. Other factors may have contributed, but it is difficult to determine (e.g. moisture content in masonry bricks).

14. Recommendations

Plans for the building have been obtained to study the footing details. However, for purposes of prescribing rectification measures and based on what we have seen first-hand and engineering drawings of the actual footings, this information is not critical:

The approach followed in the rectification process represents a dichotomy, viz:

- Underpinning;
- Incorporating measures to attempt stabilising future soil moisture change and hence curb heave/shrinkage movement as effectively as possible; and
- Protecting the structure against additional potential movement by strengthening the superstructure where necessary, but at the same time providing flexibility to it by way of movement joints (these recommendations will be done by a structural engineer).

14.1 Foundations

Due to the fact that the foundation material below the foundation is potentially collapsible and compressible, the **underpinning of the foundation should be considered and investigated**. There is a risk of cracking during the process and the shrinkage of the fresh concrete, but this will stabilize with time. It is also difficult to underpin the internal walls. Should the client select this option, the structural engineer can prepare a detailed procedure for the process.

14.2 Soil Moisture Stabilisation

Water must be kept away from the foundations. To stabilise the soil moisture around the foundations of the house an adequate apron of approximately 1.50 m width must be constructed around the house in such a way that water does not pond anywhere directly next to the structure of the house. This will require draping of the soil before placing the apron. **When carrying out the above it must be confirmed that no services are leaking.**

In addition, while a garden may be established near the buildings, no large trees should be planted near the buildings. Watering plants close to the house may have a negative effect on the moisture stabilisation below the foundation.

14.3 Professional Indemnity

Dwala Group has not carried out detailed construction supervision or design and therefore accepts no responsibility for the design and/or failures and consequences, therefore, that may occur in the future. We would, however, like to assist with recommendations for the repair of the structure.

The recommendations and methods of construction must be finalised with a contractor. It must be emphasised that all measures to render an existing structure crack free, is certainly more difficult to incorporate than in the case of a new structure still to be built. Although there is no guarantee against minor and isolated cracks developing subsequent to the implementation of these measures, a high success rate is possible, particularly to the extent of maintaining a high degree of aesthetical appeal.

15. References

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11. Weinert, H.H. 1980. The Natural Road Construction Materials of Southern Africa. Academica. Pretoria.

Appendix A

Summary of Standard Soil and Rock Profile Description Terminology

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

Term	Description
Dry	
Slightly moist	Requires addition of water to reach optimum moisture content for compaction
Moist	Near optimum content
Very Moist	Requires drying to attain optimum content
Wet	Fully saturated and generally below the water table

2. COLOUR

The Predominant colours or colour combinations are described including secondary coloration described as banded, streaked, blotched, mottled, speckled or stained.

3. CONSISTENCY

3.1 Non-Cohesive Soils

Term	Description
Very Loose	Crumbles very easily when scraped with geological pick
Loose	Small resistance to penetration by the sharp end of the geological pick
Medium Dense	Considerable resistance to penetration by the sharp end of the geological pick
Dense	Very high resistance to penetration to the sharp end of geological pick. Requires many blows of hand-pick for excavation.
Very Dense	High resistance to repeated blows of geological pick. Requires power tools for excavation

3.2 Cohesive Soils

Term	Description
Very soft	Easily penetrated by thumb. Sharp end of the pick can be pushed in 30 - 40mm. Easily moulded by fingers.
Soft	The pick head can easily be pushed into the shaft of the handle. Moulded by fingers with some pressure.
Firm	Indented by thumb with effort. Sharp end of the pick can be pushed in up to 10mm. Can just be penetrated with an ordinary spade.
Stiff	Penetrated by thumbnail. Slight indentation is produced by pushing the pick point into the soil. Cannot be moulded by fingers. Requires hand-pick for excavation.
Very Stiff	Indented by thumbnail. Slight indentation produced by the blow of the pick point. Requires power tools for excavation.

4. STRUCTURE

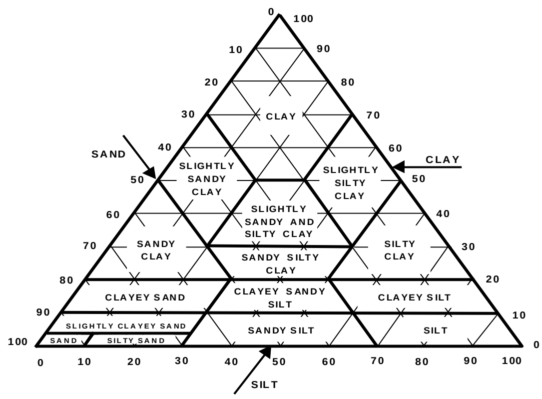
Term	Description
Intact	Absence of fissures or joints
Fissured	Presence of closed joints
Shattered	The presence of closely spaced air-filled joints giving cubical fragments
Micro-shattered	Small-scale shattering with shattered fragments the size of sand grains
Slickensided	Polished planar surfaces representing shear movement in soil
Bedded Foliated	Many residual soils show structures of parent rock.

5. SOIL TYPE

5.1 Particle Size

Term	Size (mm)
Boulder	>200
Pebbles	60 – 200
Gravel	60 – 2
Sand	2 – 0,06
Silt	0,06 – 0,002
Clay	<0,002

5.2 Soil Classification



6. ORIGIN

6.1 Transported Soils

Term	Agency of Transportation
Colluvium	Gravity deposits
Talus	Scree or coarse colluvium
Hillwash	Fine colluvium
Alluvial	River deposits
Aeolian	Wind deposits
Littoral	Beach deposits
Estuarine	Tidal–river deposits
Lacustrine	Lake deposits

6.2 Residual soils

These are products of in situ weathering of rocks and are described as e.g. Residual Shale

6.3 Pedocretes

Formed in transported and residual soils etc.
calcrete, silcrete, manganocrete and ferricrete.

SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

Term	Symbol	Diagnostic Features
Residual Soil	W5	Rock is discoloured and completely changed to soil in which the original rock fabric is completely destroyed. There is a large change in volume.
Completely Weathered	W5	Rock is discoloured and changed to soil but the original fabric is mainly preserved. There may be occasional small corestones.
Highly Weathered	W4	Rock is discoloured, discontinuities may be open and have discoloured surfaces, and the original fabric of the rock near the discontinuities may be altered; alternation penetrates deeply inwards, but corestones are still present.
Moderately Weathered	W3	Rock is discoloured, discontinuities may be open and will have discoloured surfaces with alteration starting to penetrate inwards, intact rock is noticeably weaker than fresh rock.
Slightly Weathered	W2	Rock may be slightly discoloured, particularly adjacent to discontinuities, which may be open and will have slightly discoloured surfaces, the intact rock is not noticeably weaker than the fresh rock.
Unweathered	W1	Parent rock showing no discolouration, loss of strength or any other weathering effects.

2. HARDNESS

Classification	Field Test	Compressive Strength Range MPa
Extremely Soft Rock	Easily peeled with a knife	<1
Very Soft Rock	Can be peeled with a knife. Material crumbles under firm blows with the sharp end of a geological pick.	1 to 3
Soft Rock	Can be scraped with a knife, indentation of 2 to 4 mm with firm blows of the pick point.	3 to 10
Medium Hard Rock	Cannot be scraped or peeled with a knife. Hand-held specimen breaks with firm blows of the pick.	10 to 25
Hard Rock	Point load tests must be carried out in order to distinguish between these classifications	25 - 70
Very Hard Rock	These results may be verified by uniaxial compressive strength tests on selected samples.	70 - 200
Extremely Hard Rock		>200

3. COLOUR

The predominant colours or colour combination are described including secondary colouration described as banded, streaked, blotched, mottled, speckled or stained.

4. FABRIC

4.1 Grain Size		4.2 Discontinuity Spacing		
Term	Size (mm)	Description for: Bedding, foliation, laminations	Spacing (mm)	Descriptions for joints, faults, etc.
Very Coarse	>2,0	Very Thickly Bedded	> 2000	Very Widely
Coarse	0,6 – 2,0	Thickly Bedded	600 – 2000	Widely
Medium	0,2 – 0,6	Medium Bedded	200 – 600	Medium
Fine	0,06 – 0,2	Thinly Bedded	60 – 200	Closely
Very Fine	< 0,06	Laminated	3 – 60	Very closely
		Thinly Laminated	<3	

5. ROCK NAME

Classified in terms of origin:	
IGNEOUS	Granite, Diorite, Gabbro, Syenite, Dolerite, Trachyte, Andesite, Basalt.
METAMORPHIC	Slate, Felsite, Gneiss, Schist, Quartzite
SEDIMENTARY	Shale, Mudstone, Siltstone, Sandstone, Dolomite, Conglomerate, Tillite, Limestone.

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B

Soil Profile Descriptions

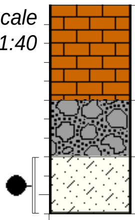
DWALA GROUP
No Limitations

NHBRC
House Bernard

HOLE No: HB1
Sheet 1 of 1

JOB NUMBER: 100150

Scale
1:40



FI

0.00 – 0.50	Brick wall.
0.50 – 0.80	Concrete Foundation.
0.80 – 1.10	Slightly moist to moist, off-white, greyish, olive green speckled yellow, MEDIUM-DENSE, intact, clayey sand with minor gravel. Residual.
1.10	END OF HOLE.

NOTES

1) Sidewalls are stable.
2) Refusal on dense residual.
3) No groundwater seepage intercepted.
4) FI, moisture content sample taken at 0.80--1.10m depth.
5) The footing is placed at a depth of 0.80m has a thickness of 0.30m and a width of 0.96m.

CONTRACTOR :
MACHINE : PICKS AND SHOVELS
DRILLED BY :
PROFILED BY : LM

TYPE SET BY : LM
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 21/02/2024

DATE : 24/03/2024 18:29
TEXT : ..HouseBernardProfiles.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: HB1
Mossel Bay

dotPLOT 7022

NHBRC
House Bernard

HOLE No: HB2
Sheet 1 of 1

JOB NUMBER: 100150

DWALA GROUP
No Limitations

Scale
1:40

0.00

Moist, dark brown-black speckled grey,FIRM to STIFF, sandy clay with gravel and pebbles.
Fill.

1.30

END OF HOLE.

NOTES

1) Sidewalls are stable.

2) No refusal.

3) No groundwater seepage intercepted.

CONTRACTOR :	INCLINATION :	ELEVATION :
MACHINE : PICKS AND SHOVELS	DIAM :	X-COORD :
DRILLED BY :	DATE :	Y-COORD :
PROFILED BY : LM	DATE : 21/02/2024	HOLE No: HB2
TYPE SET BY : LM	DATE : 24/03/2024 18:29	Mossel Bay
SETUP FILE : STANDARD.SET	TEXT : ..HouseBernardProfiles.txt	

NHBRC
House Bernard

LEGEND
Sheet 1 of 1

JOB NUMBER: 100150

	SAND	{SA04}
	SANDY	{SA05}
	CLAY	{SA08}
	CLAYEY	{SA09}
	BRICKWALL	{SA14}
	CONCRETE	{SA34}
Name	DISTURBED SAMPLE	{SA38}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : LM
SETUP FILE : STANDARD.SET

DATE : 24/03/2024 18:29
TEXT : ..HouseBernardProfiles.txt

LEGEND
SUMMARY OF SYMBOLS

dotPLOT 7022

Appendix C

Laboratory Test Results

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

Customer :	Dwala Group (Pty) Ltd	Project :	House Bernard - Mossel Bay
	Postnet Suite 073	Date Received :	22/02/2024
	Private Bag X1, Menlo Park	Date Reported :	20/03/2024
	102	Req. Number :	0492/24
Attention :	Nhlanhla Magigaba	No. of Pages :	1

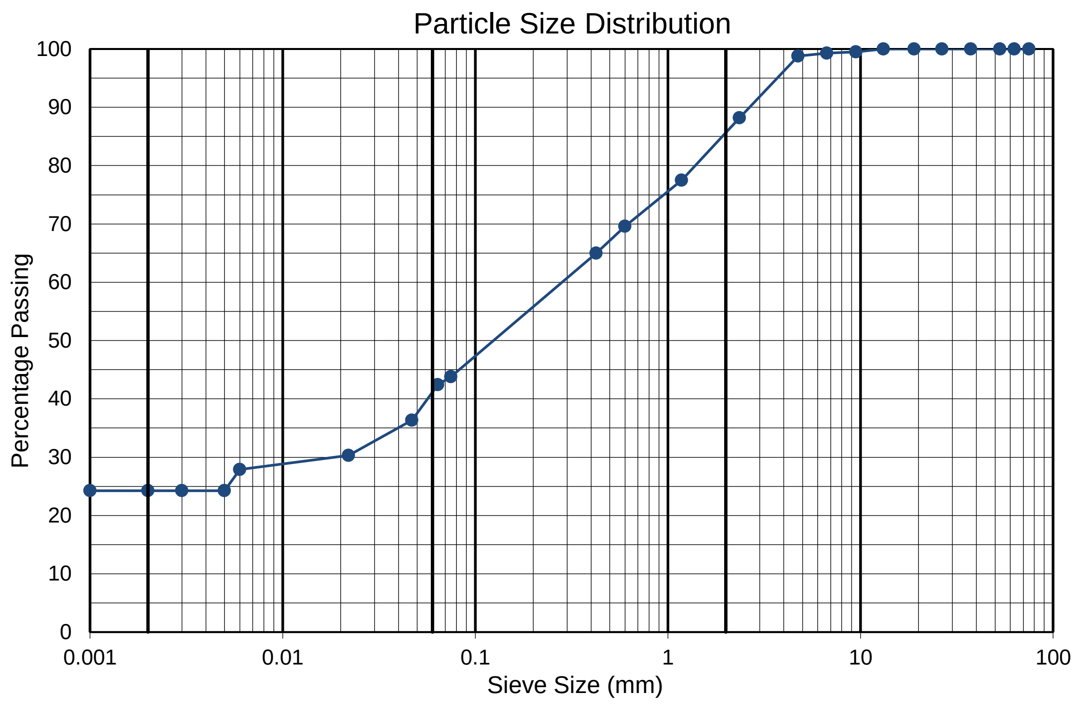
TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)			HB1
Depth (mm):			800-1100
Sample No.:			87837
Materials	Description	Source	In-situ
		Colour	Light Grey
		Soil Type	Silty Sand
		Classification	Existing

Percentage Passing

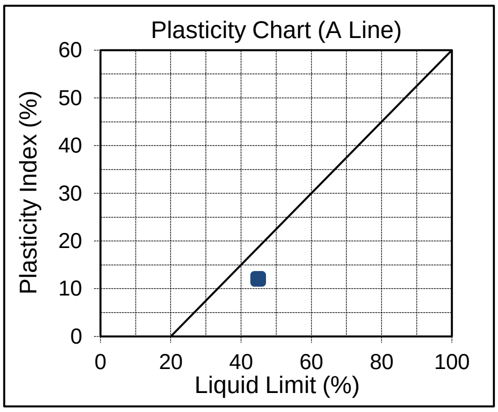
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	99
4.75mm	99
2.36mm	88
1.18mm	78
0.6mm	70
0.425mm	65
0.075mm	44
0.064mm	42
0.047mm	36
0.022mm	30
0.006mm	28
0.005mm	24
0.003mm	24
0.002mm	24
0.001mm	24

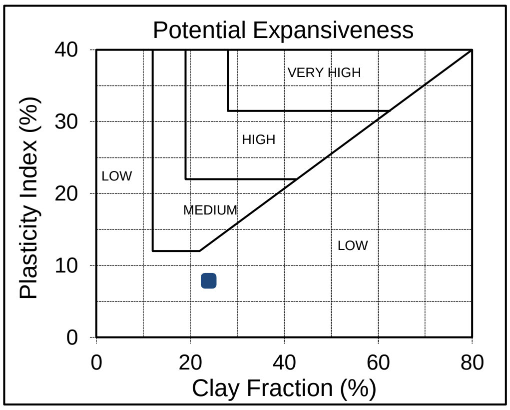


Liquid Limit (%)	45
Plasticity Index (%)	12
Linear Shrinkage (%)	6
Moisture Content (%)	32.9

% Clay	24
% Silt	17
% Sand	44
% Gravel	15

Unified Soil Classification	SM
AASHTO Soil Classification	A-7-5





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

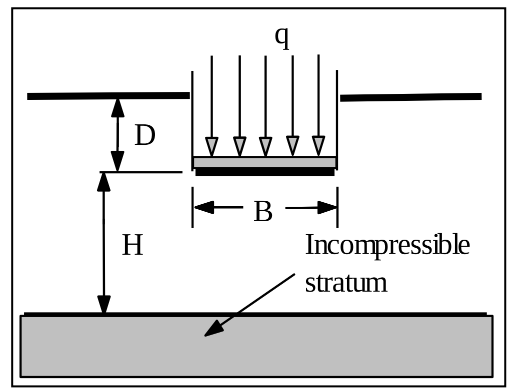
Appendix D

Settlement Calculations

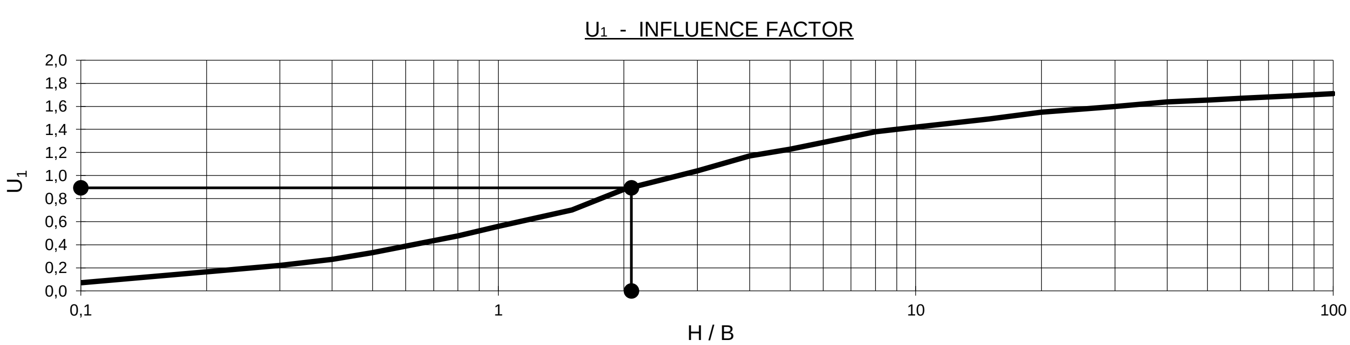
PREDICTION OF THE AVERAGE ELASTIC SETTLEMENT OF A STRIP FOOTING

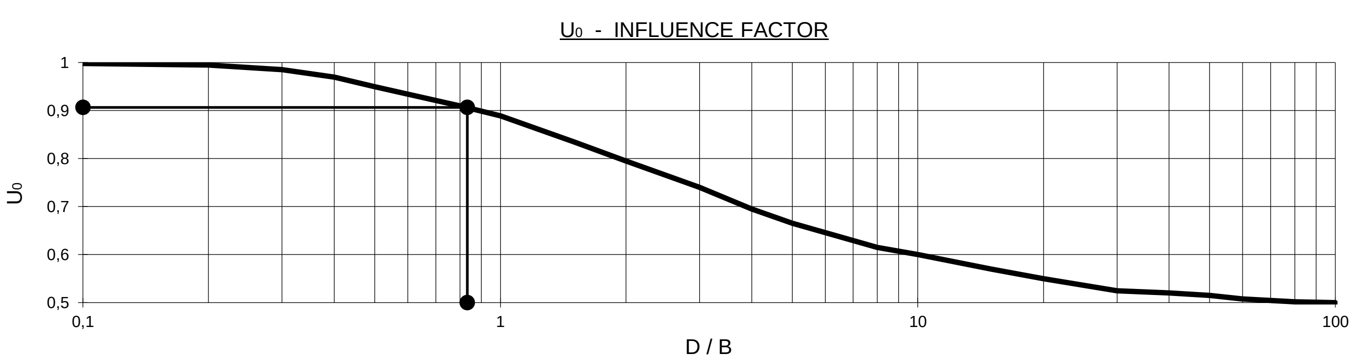
PROJECT NAME	House Bernard
PROJECT NUMBER	100150
PROBLEM DESCRIPTION	HB1 - Settlement on current in-situ residual material
LOCATION	Mossel Bay

FOUNDING DEPTH (D)	0,8 m
WIDTH OF THE FOOTING (B)	0,96 m
THICKNESS OF COMPRESSIBLE STRATUM (H)	2 m
STIFFNESS OF COMPRESSIBLE STRATUM	7 MPa
FOUNDATION PRESSURE (q)	150 kPa
H / B	2,08
D / B	0,83
U_1 - INFLUENCE FACTOR	0,89
U_0 - INFLUENCE FACTOR	0,91
AVERAGE IMMEDIATE SETTLEMENT ***	17 mm



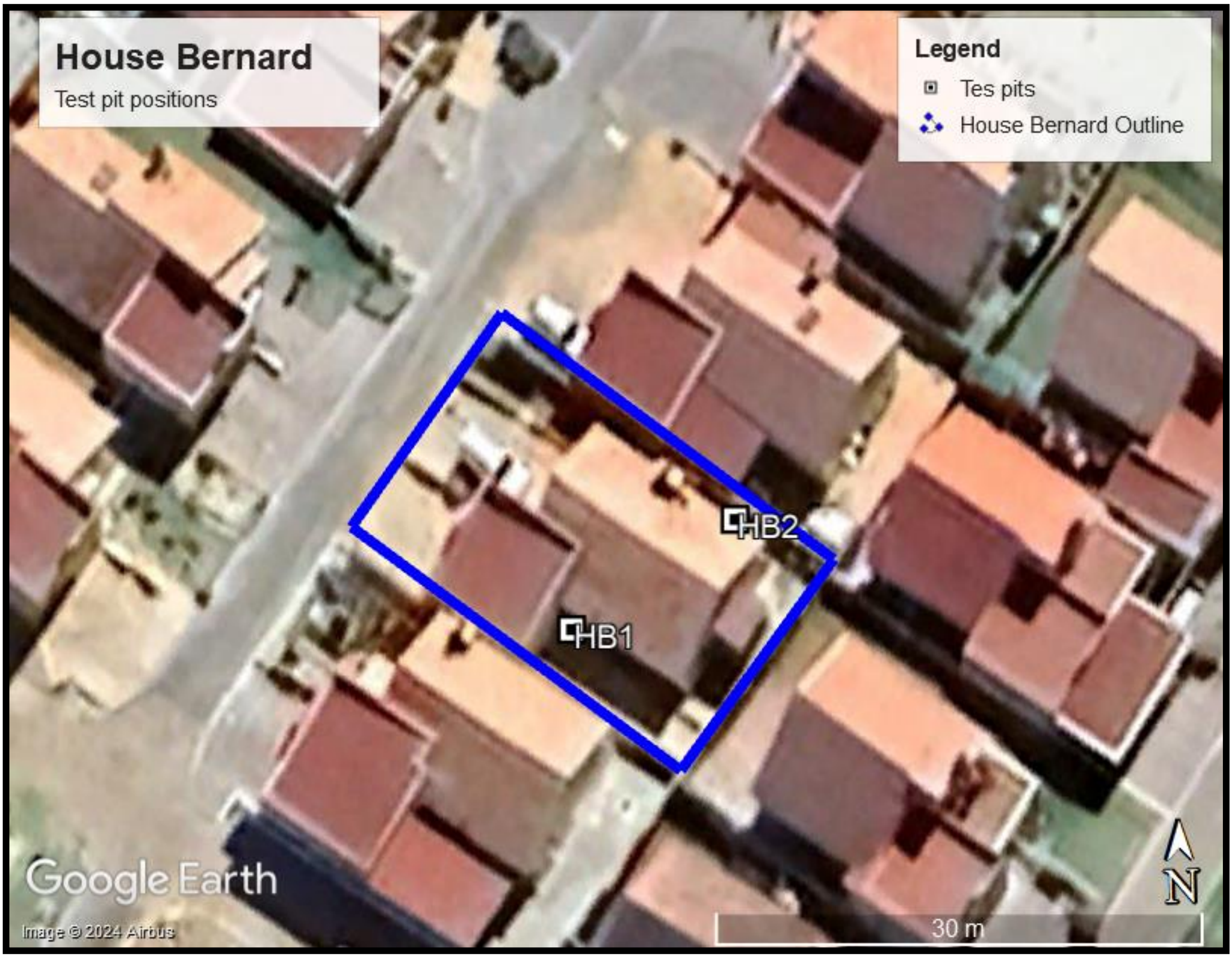
*** - After Janbu, Bjerrum and Kjaernsli for L/D <10 only





Appendix E

Site plan


House Bernard
Test pit positions
Legend
Tes pits
House Bernard Outline
HB2
HB1
Google Earth
Image © 2024 Airbus
30 m
N